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SCIENCE

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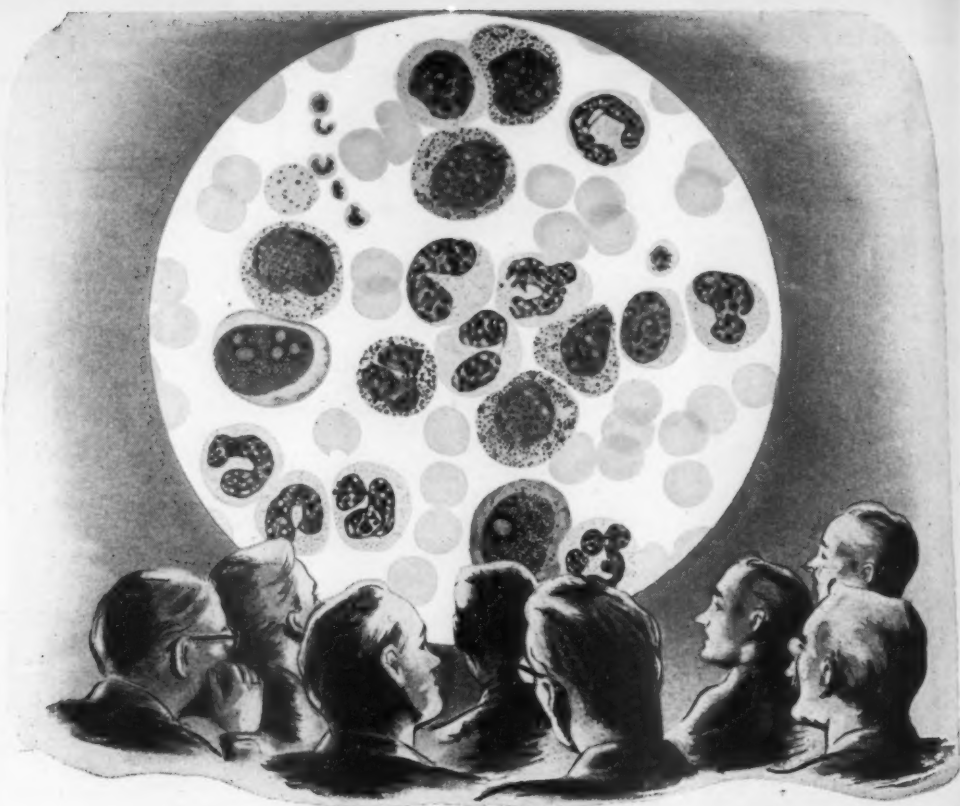
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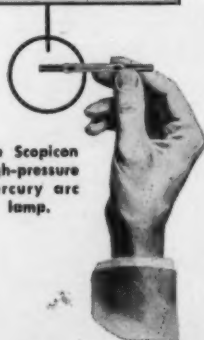


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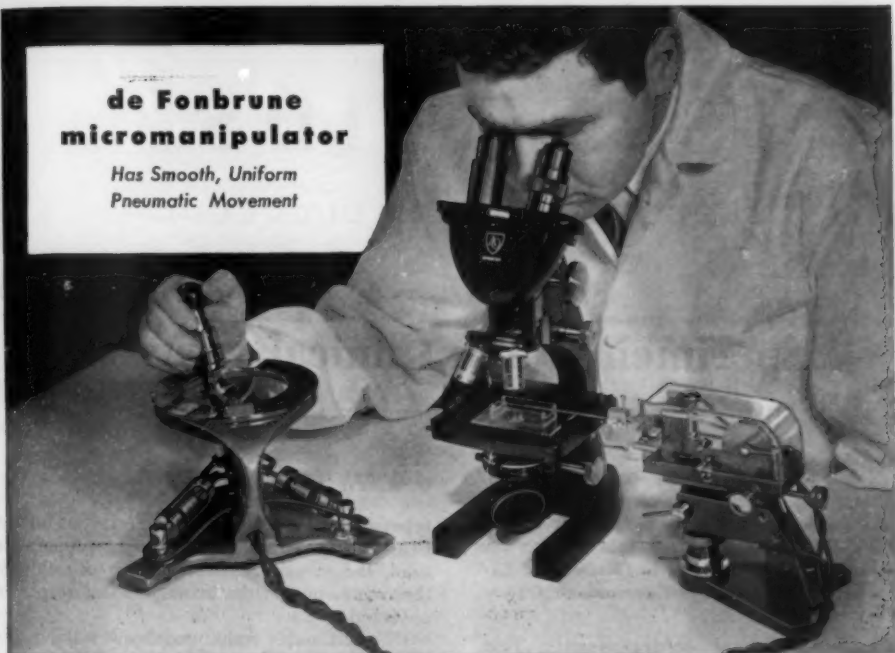
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Flare Stars and the Radio

THE cosmic significance of the radio "stars" has been mentioned (*Science*, 113, 3 [April 27, 1951]). These spots in the sky, which are empty of detectable stars, yet send short-wave signals that are superposed on the general radio noise from the Milky Way, tease the imagination and incite ingenuity in attempts to locate the sources—explain the phenomena.

A source has been found in a few instances. The expanding Crab Nebula, which was a supernova more than a million times the sun's brightness nine centuries ago, now sends a faint radio signal, presumably from the blue-hot nucleus that remains buried in the dissipating gas. The great Andromeda galaxy and three other spirals, Messier 33, 51, and 101, are now found to be radio transmitters.

It may be that the newly discovered phenomenon of flare stars provides a source of the background Milky Way static, even though it cannot readily account for radio stars. About half the fifty stars nearest the sun are now known to belong to the spectral class dM. They are dwarf, reddish stars with intrinsic luminosities less than one thousandth that of the sun—sometimes less than one ten-thousandth. Having radiated away most of their available energy, they are, presumably, asymptotically approaching a cold senility. Not many are known as yet, because they are too faint to appear in our ordinary surveys, but they are probably more numerous than any other kind of star in the universe; hence, the importance of finding out anything new about them.

A few years ago we first suspected that these near-by dwarfs are not dying off calmly. Some of them were under parallax study by A. van Maanen at Mount Wilson. Little attention was given to his report that two dM stars had flared up for an hour or so and then

reverted to their customary steady brightness, until two years ago, when, on Harvard plates, one such faint red dwarf was found, by W. J. Luyten and others, to have flashed briefly on several occasions. We began to take the flares seriously. We computed that the total energy of a star flare was something like that of the flares on the surface of the sun (which disturb terrestrial short-wave radio). Since the sun is relatively bright, these localized blue flashes do not increase its total radiation appreciably; with the red dwarfs it is otherwise—a flare can double the total light.

A little later Gordon and Kron at the Lick Observatory saw one of the red dwarfs flaring up in their faces. They measured it with a photoelectric photometer and found rapid changes, but all was soon quiet and steady. The Harvard astronomers then looked back at some earlier measures of the nearest of all stars, Proxima Centauri, which is also a red dwarf, and found flares recorded among the observations of the 1930s. Further examination of the plates shows that within the past twenty-five years fifty of these conspicuous brief flashes have occurred on Proxima Centauri. Finally, from Swarthmore comes an unpublished report that still another of these near-by flare stars is revealed in a 1939 photograph. It quadrupled its total brightness and recovered completely from the flash in an interval of two or three hours.

The implications are startling. A fourth of the near-by red dwarfs are flare stars—further study may show that most of them are flaring. We have opened up suddenly a new phase in the study of the evolution of stellar bodies. Perhaps we have also discovered the source of some of the radio signals from interstellar space.

HARLOW SHAPLEY

Harvard College Observatory

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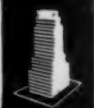
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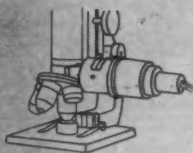
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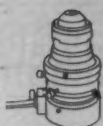


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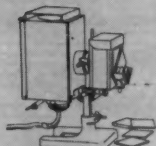
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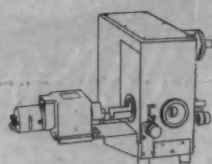
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The Importance of Science in American Education

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ABOUT FOUR YEARS AGO the editor of one of our leading chemical journals said that the dramatic story of the atomic bomb had proved once again that most of the advances in pure or fundamental research (and by this he implied not only physics, but also biology, chemistry, and medicine) had been made by citizens of other countries, or by American citizens who had received their education in Europe, or by Europeans who had emigrated to the United States (1). Since I had my education in Europe and spent more than ten years in industry there before joining the faculty of Massachusetts Institute of Technology twenty-two years ago and, since then, have also had intimate contact with some of our largest industrial concerns, I feel that I can offer an explanation as to why the statement referred to is absolutely correct. I also hope that an unbiased analysis of this situation, which under prevailing world conditions must be disturbing to every loyal American citizen, may lead to a satisfactory solution.

This opinion is shared by many others. At a recent meeting sponsored by the American Institute of Chemists, the problem of whether present education properly trains chemists for industry was the main topic. When one participant was asked if our education gives a truly satisfactory preparation in fields other than the technical to chemists entering industry, he answered with a categorical no (2). Another speaker said that, although our education provides the fundamentals, it hardly shows us how to apply them (3). At the annual meeting of the American Pulp and Paper Mill Superintendents Association, the president of the American Society of Mechanical Engineers made the following statement, in his address on "Technical Knowledge Is not Enough": "In fact, I think it can be shown that our failure to recognize and respond to our broad responsibilities as citizens and human beings, our failure to understand that technical progress is not enough, is the key to many of our greatest difficulties in America today" (4). This was pointed out long ago by Plato, when he said, "The direction in which education starts a man will determine his future" (5).

Quite recently this was emphasized again by Don G. Mitchell, president of Sylvania Electric Products, Inc., in a speech he gave in November 1950, at Northeastern University. As he expressed it, what worries industry most is that so many are able to obtain de-

grees but are unable to express themselves concisely and logically, orally and on paper. Industry expects graduates to have a mature outlook and a realization that they are no longer children to be cared for but are individuals who must be worthy of their hire.

The situation may be viewed through the eyes of men who already have offered ample proof that their primary interest is the improvement of our educational systems. Recently the U. S. Commissioner of Education drew attention to the undeniable fact that a very great number of educational institutions still organize their curricula in watertight compartments, and that all efforts to penetrate the barriers between departments are jealously resisted (6). In an article of very recent date, a former college professor and president points out that we are far too reluctant to insist on those formative disciplines which alone can promise proficiency in doing and thinking, and that our schools are seriously crippled by the assumption that the acquiring of the skills and the understanding necessary for effective thinking and honorable living is really quite easy. He also expresses the opinion that the teacher's art should be to devise ways of imparting to the learners a respect for the basic wisdom of their forebears (7).

The basic difference between a German and an American university or college is that the latter permits the student to devote himself to a specialized branch of science or technology far too early, so that the last college years are used as preparation for an advanced specialized education, thereby cutting down the time that should be devoted to general education (8). Another essential difference between our training technique and that used in Europe is that we use systematic drilling as a method of instruction; this can provide sound knowledge, but is hardly likely to promote self-reliant thinking and the spirit of research. The excessive use of the textbook may also be criticized because it works in the same direction (9).

To find a truly satisfactory explanation for this difference, it is necessary to probe more deeply into the educational systems of Europe and the United States. First of all, it must be borne in mind that throughout most of Europe only those who have graduated from the *Gymnasium* or *Realschule* may enroll in a university or comparable technological institute. When graduating from one of these schools, which they have had to attend for eight years (having left grammar school at about ten or eleven), students have acquired

a background of general education at least comparable to that of American students starting the junior year in college.

Having given this problem considerable thought ever since becoming fully acquainted with our educational system as a faculty member of the two leading technological institutions in the Commonwealth of Massachusetts, and also after having been closely connected with industry, where prosperity will always depend on the qualities acquired by the younger generation during their education, I have come to the conclusion that what we need more than anything else is to offer all students a more general appreciation of what science actually stands for. As President Conant, of Harvard University, has said:

One of the difficulties in presenting science as part of general education at both the school and college level is that of selection. The progress in all the sciences in the last three hundred years has been so great that the factual information is enormous. Even the selection of the major principles to be expounded is no easy matter. Questions of the reality of atoms, molecules, electrons, neutrons, not to mention photons and light waves and three-dimensional space, we should want to postpone to a college course. And even at the college level some of us would doubt the student's ability to handle them adequately as part of science. Rather, we should direct our students to study philosophy to see the various types of current answers (10).

Perhaps of even greater importance for anyone interested in the problem of why science is essential in modern education are the following statements (11):

What is needed are methods for imparting some knowledge of the Tactics and Strategy of Science to those who are not scientists. But even if we agree that it is not more knowledge about science (more facts and principles) but some understanding of science that is required by the general public our pedagogic problem is not solved. For there are two ways of probing into complex human activities and their products: one is to retrace the steps by which certain end results have been produced, the other is to dissect the result with the hope of revealing its structural pattern and exposing the logical relations of the component parts, and, incidentally, exposing also the inconsistencies and flaws. Philosophic and mathematical minds prefer the logical approach, but it is my belief that for nine people out of ten the historical method will yield more real understanding.

The objective would be to give a greater degree of understanding of science by the close study of a relatively few historical examples of the development of science.

The case histories would almost all be chosen from the early days in the evolution of the modern discipline, as for example certain aspects of chemistry in the eighteenth and nineteenth centuries. The advantages of this method of approach are twofold: first, relatively little factual knowledge is required either as regards the science in question or other sciences, and relatively little mathematics; second, in the early days one sees in clearest light the necessary fumbings of even intellectual giants when they are also pioneers; one comes to understand what science is by seeing how difficult it is in fact to carry out glib scientific precepts.

Along similar lines, I. Bernard Cohen, of Harvard,

quite recently said that we can give students a more general appreciation of what science stands for by making them more familiar with the human side of those to whom we owe the greatest discoveries in science, and with the circumstances that led them to the accomplishments for which they are now famous (12). A few specific examples will lend support to my opinion that this would be the best way of demonstrating the importance of science in education.

Henry Louis Le Chatelier (1850-1936) pointed out that the factors most necessary for successful education are enthusiasm, judgment, imagination, and a large fund of organized knowledge. These factors must be imparted to the student by the teacher himself, because a textbook can never accomplish it (13).

In the Bakerian Lecture that Michael Faraday delivered in 1857 (14), he pointed out that, if a drop of a solution of phosphorus in carbon disulfide is added to a solution of gold chloride and the whole is well shaken together, the solution immediately becomes red. Although the solution was absolutely clear, Faraday concluded, on the basis of his knowledge of the reaction that must have taken place, that metallic gold should be present in the solution. On the assumption that this solution might be analogous to what looks like clean air in daylight but which in the dark will show the path of a concentrated beam of light, he placed the container of gold solution in a darkened room in front of a concentrated light source. The particles were then evident because the cone of light passing through the solution became visible, even though the illuminated particles themselves could not be individually distinguished because of their minuteness.

For fifty years thereafter the majority of scientists still claimed that the visibility of the light cone in such solutions was made possible only by the presence of impurities or comparatively large, suspended gold particles. One of the strongest supporters of this so-called solution theory was Richard Zsigmondy. By pure logical reasoning and strict adherence to the truth of experimental evidence, however, he was the first to prove and admit that he was wrong in his former deductions, and that the so-called heterogeneous theory of colloidal solutions, postulated many years before by Wilhelm Ostwald (8), was correct. He decided to replace the human eye with a microscope, place such a gold solution under it, and pass a concentrated beam of light through it. In the publication in which he discussed this experiment and in which he refuted the solution theory (15), he made the following statement:

How entirely erroneous was this idea! A swarm of dancing gnats in a sunbeam will give one an idea of the motion of the gold particle in the solution. This motion gives an indication of the continuous mixing up of the fluid, and it lasts hours, weeks, months, and if the fluid is stable, even years.

Near the end of the year 1895 Wilhelm Konrad Roentgen, at that time professor of physics at the University of Wuerzburg in Bavaria, discovered that,

if he placed crystals of barium-platino-cyanide near a Crookes tube, they became brilliantly fluorescent, even if he covered the tube with cloth. He also found that photographic plates, which had been well protected against light and had never been exposed, would show complete darkening after development if they had been left lying close to the covered tube when it was in use. This phenomenon had already been noticed previously by Sir William Crookes himself, who blamed the darkening on the manufacturer of the plates. When Roentgen found, however, that a piece of metal or bone placed between the Crookes tube and the photographic plate would show a white or slightly grayish reproduction of its shape on the developed plate, he immediately concluded that the tube was emitting rays invisible to the human eye, but capable of a reaction within the photographic emulsion. Furthermore, he concluded that this radiation must be of such a wavelength that it passed certain structures unhindered, but was absorbed by others to a greater or less degree, depending on their character. This is the basis for the discovery of the x-ray techniques now so important in many branches of science, including medicine.

Using these deductions, the German physicist Max von Laue theorized early in 1912 that the lattices of crystals which indicated a periodicity of about 10^{-8} cm should act as gratings for x-rays and diffract them in definite directions. By passing a narrow beam of x-rays through a crystal and placing a photographic plate behind it, it was found that the plate was covered with a regular pattern of spots. This was exactly what von Laue had predicted. With rotation of the crystal while the exposure was being made, the individual dots changed into a series of dots showing a well-defined pattern. From this discovery Peter Debye and P. Scherrer reasoned that the various dots are due to every crystal plane coming into a reflecting position, the reflection then being registered on the photographic plate, and that it should be possible to obtain a pattern suitable for an evaluation of the structure by placing powdered crystal in front of the x-ray beam. They further reasoned that by the law of probability all possible reflection angles should be available in such a powdered column, comparable to results obtained when a perfect crystal is rotated in front of the x-ray beam. This is the basis for the development of the so-called powder method (16).

Other discoveries offer excellent proof of the important part logical thinking plays in any field of scientific research. In 1889 two physicians found that the urine of dogs from which the pancreas gland had been removed became sweet in comparison to that of healthy animals. From this observation, they postulated that this must be due to the withdrawal from the body of a hormone that regulated the metabolism of carbohydrates. In 1921 it was discovered that extracts of partially degenerated pancreas glands contained this substance. Soon thereafter it was found that this substance, now known as insulin, could be extracted with alcohol and purified by fractional pre-

cipitation. The foundation for modern diabetes theory had been laid.

In another branch of medicine similar reasoning has quite recently made possible a new approach to the treatment of kidney stones; unquestionably, detailed reports pertaining thereto will be forthcoming in the near future.

The rubber latex industry offers additional proof of how much more important logical thinking is than anything else for the further development of science and technology. In the early 1920s it was known that cow's milk could be concentrated by careful evaporation, and even made into a powder by spray-drying. If such milk powder was dissolved in the proper quantity of water, milk of unchanged properties resulted. When the same experiment was carried out with the milk exuding from the rubber tree, little rubbery particles formed that adhered to each other readily and could not be put back into solution. The experiment was considered a failure and was discontinued. One young man who witnessed these tests decided to get to the bottom of the problem, so he carried out some chemical analyses and made microscopic studies. He found that the butterfat particles in cow's milk are much larger than the rubber hydrocarbon particles in latex. He also found that the casein, which acts as a coating for the emulsified butterfat particles, is present in higher concentration for a given amount of butterfat than the protein constituent of the latex in relation to the rubber particles. Since the latter are much smaller, the interface between emulsified rubber hydrocarbon and water is much greater than the interface in cow's milk. From these facts he drew the logical conclusion that the failure of the concentration experiment was quite independent of the chemical composition of the two emulsions, and was due only to the lack of a quantity of emulsifier sufficient to cover the much greater interface in the rubber latex. The only solution of the problem indicated by these results was to add an appropriate emulsifier, or protective colloid, to make up the difference in concentration. The experiment turned out successfully. The first concentrated, redispersible rubber latex had been made.

I might also mention that our entire wartime production of synthetic rubber would have been impossible if we had not had at our disposal all the information that led German scientists, on the basis of straight, logical thinking, to the development of the process of emulsion polymerization.

Some years ago it was found that gels made from a certain type of natural clay known as bentonite would, when spread out on an appropriate surface, form a very thin, coherent film upon desiccation. Although this film exhibited dielectric properties comparable to those of the best mica available, it had the drawback of completely degenerating in the presence of moisture. It was decided to find out what might be the reason for the difference between this film and natural mica. As a result of careful chemical analysis, x-ray diffraction studies, and ultramicroscopic obser-

vations, it became evident that the main reason for the difference was the lack of potassium ions in the synthetically formed system. As soon as these, or other ions comparable to potassium in size and charge, were introduced into the film by a simple chemical process, a product resulted that was comparable in every respect to the finest mica available. It was this material that helped our nation during World War II to overcome the serious shortage of natural mica, which had previously been imported from India (17).

I have selected these examples because a survey of the textbooks now used to educate our young people reveals a serious lack of this type of information. The inclusion of such material explains to the reader in terms he can understand, even if he does not intend to become a scientist, not only what science stands for and how new discoveries are made, but also on what logical reasoning the latter are based. This would give the educator a unique opportunity for impressing on his students that the introduction of the history of science into general education need not be limited to prospective scientists. Its main purpose would be to offer the younger generation factual evidence of the importance of clear and logical thinking in the evolution of mankind, and to impress on them that this deserves more respect than acquiring a command of mathematical equations, chemical formulas, and the like. It is of far greater significance in a general education than a smattering of specific sciences without the basis really to understand them. In a world such as ours it is our duty to change the educational system so that every citizen is taught science in a manner he can understand, and without unnecessary and frequently outdated dogmas. At the Regional Conference on Teacher Education and Professional Standards held at Harvard University on December 15, 1950, Finis E. Engleman, Connecticut Commissioner of Education, said that "in this time of international strain, children are likely to be our first casualties through neglect of education." The true purpose of education should be not to make living textbooks, so to speak, but to do what Socrates pro-

claimed—namely, to achieve individual independence and spiritual self-reliance. The true purpose of science always has been, and should remain, to serve life and not to dominate it. What we must do is to give our young people such a grounding in the philosophical principles on which the evolution of science is based as will prove to them that textbook knowledge alone is insufficient. To accomplish this we must change our curricula so that more emphasis is placed on the disciplines that teach proficiency in doing and thinking—for example, by offering courses on the historical development of science and technology and what has been accomplished thereby in other countries, as well as in our own.

In addition, we must also realize that such a change will be difficult, if at all possible, as long as those responsible for the selection of high-school headmasters and college and university presidents are more interested in satisfying political, religious, economic, and local interests than in obtaining for such positions individuals who can offer proof that they already have devoted, and are prepared to continue to devote, their lives primarily to science in education.

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Technical Papers

Studies on Pollination of *Hevea Brasiliensis* in Puerto Rico¹

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Although many studies of pollination in the Para rubber tree, *Hevea Brasiliensis* (Willd. ex A. Dr. Juss.)

¹ Cooperative investigation with the Division of Rubber Plant Investigations, BPISAE, Beltsville, Md.

² Administered by the Office of Experiment Stations, Agricultural Research Administration, USDA.

Muell. Arg., have been made, the actual method of pollination in nature has remained a puzzle. The fact that *Hevea* is monoecious, with the anthers and stigmas borne on the same inflorescence but in separate flowers, makes it necessary that a transfer of pollen occur. Moreover, the indication that at least certain clones are highly self-sterile makes it necessary that pollen be transferred not only from male to female flowers, but also from one tree to another, for sexual reproduction to occur.

Evidence has pointed strongly to insect pollination in *Hevea*. The flowers are colored, have a character-

istic odor, and the reproductive portions are well enclosed within the corolla. Inflorescences containing numerous male and female flowers, when enclosed in insectproof bags, fail to set fruits (1,2), even on trees known to be partially self-fertile. The pollen grains themselves are heavy and sticky and are not produced so abundantly as among the common wind-pollinated species. Vaseline-coated slides have failed to collect pollen when placed among *Hevea* flowers (2).

In no instance, however, has an insect been shown to be the pollinating agent. In Indonesia and Malaya various small flies and bees, bugs, ants, weevils, and caterpillars (1,3) have been observed about *Hevea* flowers. Morris captured and examined 3 or 4 sorts of bees, which he watched enter male flowers for pollen. The baskets on the legs of these insects were filled with pollen which was identified under the microscope as that of *Hevea*. Nevertheless, not one of these insects was seen to enter a female flower. Seibert (4), working in South and Central America, reports finding many ants on *Hevea* flowers and considers that these may be factors in self-pollination, but not in cross-pollination. He suggests species of *Melipona*, *Trigona*, and *Augochlora* as possible night-flying pollinators. Muzik (2), working in Liberia, reports that during months spent in hand-pollinating rubber trees practically no insects were ever seen. He was not able to determine how natural pollination is accomplished.

Last spring (1950), during the examination of the stigmas of a large number of female flowers under a dissecting microscope, to determine whether the low fertility in *Hevea* (frequently 5%, or less) was possibly due to inadequate pollination, a discovery was made that throws new light on the problem of insect pollination in this species. A majority of open flowers were found to have small brown hairs or bristles caught on the sticky stigmatic surfaces. These hairs were so small they could be seen only under a dissecting binocular. They generally were found in patches, and then usually on the sides of the stigmas—as if brushed off on the sticky surfaces by some small insect which crawled in between the stigma and the narrow corolla tube. These hairs were found on a large portion of *Hevea* flowers; in one series of counts, hairs were found on 101 of 128 stigmas examined at random.

There also appeared to be a positive correlation between the presence of hairs on the stigmas and the presence of pollen grains. In the same group of 128 stigmas, pollen grains were found to be present on 98. On 88 of these 98 stigmas with pollen, hairs also were found. Thirteen of the 30 stigmas without pollen had hairs, and 17 had none. Further evidence of a relation between the presence of hairs and pollination was afforded by a study of another group of flowers, selected as having been open only a few hours. In these flowers (where a possible relation between the position of hairs and pollen grains on the stigmas was not complicated by multiple insect visits), pollen grains and hairs were found to be located in the same

general area on the stigma in 33 of 38 flowers. This would suggest that pollination of *Hevea*, in a majority of cases in Puerto Rico, is associated with the visits of insects which leave telltale hairs on the sticky stigmas on entering and leaving the flowers.

No insects were observed to enter the female flowers. In an attempt to capture the unidentified insect, 3" x 5" cards were spread thinly on one side with an adhesive compound² and wrapped in loose cylinders around the branches, just below the inflorescences. During 24 hr, these cards captured scores of insects, mostly thrips, *Frankliniella cephalica* (Crawf.);⁴ numerous small flies, among them *Eugarax insularis* Mall, *Oscinella forbesi* Curr.; various unidentified species of *Chrysotus*, *Thrypticus*, *Hybos*, *Megaselia*, *Phleomyia*, *Drapetis*, and *Gaurax*; and several heleid midges of the genus *Dasyhelea*. These midges were found to have body bristles and antennal hairs very similar to those observed on the stigmas of pollinated flowers.

To limit the captured insects more precisely to those that entered, or at least rested on, the flowers a quantity of the adhesive compound was warmed and touched lightly to the recurved petal tips of a group of young female flowers. After 24 hr, 111 treated flowers were removed from the trees and brought to the laboratory for examination. These were found to have 26 thrips; 15 heleid midges of the genera *Dasyhelea*, *Atrichopogon*, and *Forcipomyia*; 9 small flies, including *Palaeosepsis furcata* (Mel. & Spuler) and *Platophrymia nigra* Will., and others similar to those caught on cards; and 2 or 3 small wasps of the genera *Pseudeucoila* and *Goniozus*. When stigmas from fresh flowers were touched to the wings and backs of these insects, only the midges were found to shed hairs freely. The hairs from the midges, when mounted and studied under the compound microscope, appeared to be identical with those previously recovered from the stigmas and similarly mounted.

It would thus appear that the insects responsible for shedding the hairs on *Hevea* stigmas are midges of the family Heleidae. Subsequently, some 22 living and dead specimens (6 males and 16 females) were found stuck to the stigmas of untreated flowers. Apparently the stigmatic surfaces are sufficiently sticky that these small insects not only lose bristles when entering and leaving the flowers but are themselves sometimes caught. This is especially true when the wings happen to come in contact with the stigma. Among the midges caught in *Hevea* flowers, many were found to carry pollen grains on their bodies. As many as 12 grains were counted on a single male on the bristles of the thorax, head, and antennae. These grains are held loosely among the bristles, where they could easily be deposited on the sticky stigmas by chance contact.

It was noted above that another small insect, thrips,

² Tree Tanglefoot, manufactured by the Tanglefoot Co., Grand Rapids, Mich.

⁴ All insect identifications were made by members of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine, USDA, Washington, D. C.

was also abundant on *Hevea* flowers. Thrips were found to be so numerous during the course of these investigations that probably very few flowers escaped their visits. There are indications, however, that thrips are not as important pollinators of *Hevea* as are the midges. It is clear that thrips are not responsible for leaving the hairs on the stigmas. Although placed on the stigmas and roughly rubbed back and forth with a dissecting needle, several live thrips failed to leave any hairs on the sticky surfaces. Thrips also were observed to carry very little pollen on their bodies, and this was usually stuck in masses of latex with which the insect had come in contact. Pollen so held is extremely difficult to dislodge. Finally, this species of thrips appears to move largely by crawling and hopping and to have little or no capacity for sustained flight. This suggests that any pollination accomplished by thrips would likely be from pollen of the same inflorescence (self-pollination). In fact, the stigmas observed to have pollen grains but not hairs may be in part the result of thrips' activity. This viewpoint is strengthened by the observation that stigmas with pollen grains only are less adequately pollinated than those with both hairs and pollen (22 stigmas with pollen only had an average of 4 grains/stigma, as compared with more than 16 grains/stigma for 38 having both hairs and pollen).⁵

The various small flies caught in the adhesive on the cards and petals, though numerous, are not believed to be of importance in pollination. They were never seen to be carrying pollen on their bodies, and none was ever observed to enter a female flower. Any pollination accomplished by them would seem to be accidental rather than systematic.

Pollination in cacao (*Theobroma cacao*), prior to the recent work in Trinidad, had been about as much of a puzzle as that of *Hevea*, and it is interesting that eventually midges of the same family as those described in the present report were found to be the effective pollinating agents. Posnette (5) showed beyond any question that heleid midges (identified as *Forcipomyia quasi-ingrami* Macfie, *Lasiohelea nana* Macfie, and *L. styliifer* Lutz [6]) are the chief pollinators of cacao in Trinidad. Midges of this group are thus known to carry pollen and to be effective pollinating agents in another plant species.

The habits and life histories of the heleid midges are not well known. Some species have aquatic larvae, and others are thought to breed in damp soil or decaying organic matter. The breeding places of the midges found in the *Hevea* plantings at Mayaguez are not known; nor is it known whether these insects are of importance in *Hevea* pollination outside Puerto Rico. The family has a wide distribution, however, and it is possible that their habits and small size (about 1 mm

⁵ That thrips are responsible for some pollination in *Hevea* seems certain after a recent observation. Female flowers tightly covered with soda straws immediately before anthesis sometimes were found to have pollen grains on their stigmas when carefully examined some days later. An occasional thrips was found inside such covered flowers, and it is highly unlikely that any other insect could have gained access to these stigmas.

in length) may have caused them to be overlooked in previous pollination studies. Actually, at no time during the present studies have these insects been observed in flight around *Hevea* inflorescences. If the hairs or bristles had not accidentally been found on the stigmas and the midges identified from this clue, their potential role in pollination might not have been discovered.

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Rate of Circulation of the Body Fluid in Adult *Tenebrio molitor* Linnaeus, *Anasa tristis* (de Geer), and *Murgantia histrionica* (Hahn)

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The rate of circulation of body fluid in insects and the time for an introduced material to become homogeneously mixed with it are important factors in certain studies in insect physiology and toxicology. Only brief, incidental references to the rate of circulation of insect body fluid have been found in the literature (1-5). Much more is known about the rate of movement and mixing of mammalian blood. The times for blood movement between comparable points in various mammals are: rabbit, 7.5 sec; dog, 16 sec; man, 23 sec; and horse, 28.8 sec (6). The time for complete mixing of the blood in man has been estimated to be between 2 and 4 min (7-9). The time for complete mixing of the blood in dogs is about 5 min (10).

Since insects have an open circulatory system, it may be more nearly correct to speak of the time for uniform mixing of insect blood rather than of the time for a complete circuit of any portion of it. One of the standard (and best) ways to determine the time of circulation of the blood of an animal is to introduce a substance whose concentration can be determined in a small portion of the blood. Elements such as phosphorus, which are normal constituents of insect blood, and which can be made radioactive, make it possible to use this method on even the smaller insects.

The usual path of the circulating blood in an insect is anteriorly through the dorsal vessel and posteriorly through the ventral portion of the body cavity (11, 12). A substance injected near the posterior end of the heart would be expected to reach first the wings, then the antenna, and first, second, and third pairs of legs in order. As the blood containing the injected substance reaches an appendage, e.g., the antenna, the amount present will increase to a maximum in each of the pair and then decrease as unadulterated blood fol-

lows. If we can find the time of this maximum we know the time for circulation. In the open circulatory system of an insect there is considerable mixing, and the maximum is not sharp, so that all one usually finds is a time beyond which no further increase in concentration of added substance occurs. This time for reaching maximum concentration can be found by removing one appendage of a pair and later, after mixing is complete, removing the other. If the concentrations are the same in the two appendages, the maximum occurred at or before the time of removal of the first appendage. If the first removed appendage has a lower concentration the time of maximum had not been reached.

The speed of mixing in the blood of an injected solution containing radiophosphorus was determined in the adults of three species of insects: the yellow meal worm, *Tenebrio molitor* Linnaeus; the squash bug, *Anasa tristis* (de Geer); and the harlequin cabbage bug, *Murgantia histrionica* (Hahn). Adults were injected with a 3% aqueous solution of Na_2HPO_4 containing radiophosphorus,¹ using a mounted microinjector. The solution used had a radioactivity of 100–200 $\mu\text{c}/\text{ml}$. About 0.001 μc was needed for a satisfactory test with the counter, and 0.1–0.6 μc was injected, in 1–3 μl of solution. All injections were made at room temperature. At various times after injection, an appendage (leg, antenna, or wing) was cut off, and the amount of radiophosphorus present was determined with a Geiger-Mueller counter. After a time long enough to ensure complete mixing of radiophosphorus in the blood, the corresponding appendage on the other side of the insect was removed and its content of radiophosphorus was determined. If the first appendage of a pair had less radiophosphorus than the second, the former was presumed to have been cut off before the injected solution was evenly distributed in the body fluid. If the same radioactivity was found in the two appendages, distribution of the radiophosphorus was considered to have been complete before the first was removed. It was shown that the radiophosphorus would reach corresponding appendages on each side of the insect at essentially the same time. In 10 experiments corresponding appendages from both sides were cut off simultaneously to check the assumption that the injected solution would reach them at the same time. The greatest percentage of deviation from the average radioactive content of a given pair of appendages was 30%; the least, 4%; the average, 12.5%.

Experiments showed that neither the presence of radiophosphorus nor the injection techniques caused any obvious departure from the normal in the insects used. Adult *T. molitor* that had been fed radiophosphorus as larvae reproduced. Seven adult *T. molitor* injected with 2 μl or more of the radiophosphorus solution survived on the average as long as 3 insects that were not injected. The rate of heart beat did not change significantly in at least 10 of 14 adult *T.*

TABLE 1
TIME FOR UNIFORM MIXING OF INJECTED
RADIOPHOSPHORUS

Insect species and site of injection	Appendage				
	Wing*	Antenna*	First leg*	Second leg*	Third leg*
<i>Murgantia histrionica</i> Posterior abdomen venter	— 14	15 15	16 17	23 22	21 22
<i>Murgantia histrionica</i> Anterior abdomen venter	10 14	18 15	19 23	24 25	23 25
<i>Murgantia histrionica</i> Head vertex	23 18	2 1.5	7.5 7.2	15 14	19 19
<i>Anasa tristis</i> Posterior abdomen venter	— —	25 25	27 23	32 32	35 33
<i>Tenebrio molitor</i> Posterior abdomen venter	— —	— —	7 6.5	10 6.5	5 —
<i>Tenebrio molitor</i> Posterior abdomen dorsum	2 14	— —	4.5 8	— —	— —

* First figure of each pair is maximum time in minutes at which mixing was not complete. Second figure is minimum time at which mixing was complete.

molitor injected with water, radiophosphorus solution, or a saline solution.

The results are shown in Table 1. It is to be expected that, since different individuals were used in each experiment, the minimum time in one insect may exceed the maximum time in another insect of the same species. The "average" time needed for complete mixing lies somewhere between the two values. The data showed that in *M. histrionica* and *A. tristis* radiophosphorus reached different appendages at different times. The injected solution usually reached the appendages in the following sequence: wings, antennae, and first, second, and third legs. The starting point of this sequence varies with the site of injection. Fluctuation in the radioactivity of appendages cut off before a maximum amount of radiophosphorus had reached them may occur, but in most experiments there were no significant fluctuations in radioactivity after the maximum had been attained. Apparently, therefore, the time for a complete circulation of the body fluid and the time for complete mixing of the injected solution were the same.

M. histrionica were injected in three places in different experiments, ventrally at the anterior and posterior ends of the abdomen, and at the vertex of the

¹ Obtained through the courtesy of the Radiation Laboratory of the University of California in 1939.

head. The sequence in which appendages received the maximum radiophosphorus content was the same regardless of the point of injection; the wings were reached by the radiophosphorus first after injection in the abdomen and last after injection in the head. When the insect was injected in the head the first pair of legs consistently showed a decrease after an initial rise to a maximum radiophosphorus content. Apparently the injected solution was very poorly mixed with the body fluid in so short a distance. Complete mixing of the body fluid required about 25 min. In *A. tristis* the order in which the radiophosphorus reached the appendages was the same, with a time to a maximum of about 35 min. Not enough experiments were performed with *T. molitor* to show the sequence in which the radiophosphorus reached the appendages. The time for uniform mixing can be estimated at 8-10 min.

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An Instance of the Occurrence of Carcinogenic Substances in Certain Barnacles¹

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The chromatographic fractionation of some extracts obtained from a sample of the hatched barnacle (*Tetracita squamosa rubescens*) showed on lime and alumina columns the presence of several zones that displayed intense blue fluorescence in ultraviolet light. Some of the fractions were crystallized and gave in hexane solution extinction curves that were typical for polycyclic aromatic hydrocarbons. The carbon and hydrogen content of one of these fractions (5 mg from 1 kg barnacles), as well as the observed molecular weight, corresponded to the values calculated for benzpyrenes. Furthermore, a spectroscopic examination, although also indicative of accompanying isomers or close analogs, demonstrated the presence of 3,4-benzpyrene in the crystalline mixture. Conse-

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quently, this particular sample was tested on mice for carcinogenic activity.

The material was dissolved in triacrylin, 5 mg/ml. Twelve male C_3H mice, 3 months old, received a single subcutaneous injection of 0.5 mg in 0.1 ml; 12 additional mice were injected with 0.25 mg in 0.05 ml. The mice were maintained on Purina dog chow and an unlimited supply of water. They were examined weekly for the presence of progressively growing tumor at the site of injection.

Four of 12 mice receiving 0.5 mg of the material developed subcutaneous tumors in 16, 17, 19, and 20 weeks following injection. Two of 12 mice receiving 0.25 mg developed tumors in 17 and 19 weeks. The remaining 18 mice were alive and free of tumor 36 weeks after injection.

The mice with tumors were sacrificed when the tumors reached 1-2 cm in diameter. On histologic examination, all 6 were seen to be spindle-cell sarcomas with local invasion of areolar and muscular tissue. Morphologically they were indistinguishable from tumors induced with 3,4-benzpyrene and other polycyclic carcinogenic hydrocarbons (1). The first tumor to be noted was transplanted into six C_3H mice and grew vigorously within 10 days, maintaining its sarcomatous appearance.

Previous data (2,3) showed that 80-90% of C_3H male mice developed sarcomas within 20 weeks after the subcutaneous injection of 0.25-0.5 mg of 3,4-benzpyrene dissolved in triacrylin. The incidence of approximately 25%, and the longer latent period of the tumors in this investigation, suggest that the material tested contained 10-40% of the active carcinogen, assuming that 3,4-benzpyrene was the only such compound present and that other substances in the sample did not alter the carcinogenic reaction. The presence of an active carcinogen was unquestionably demonstrated.

Comparative work on barnacles has shown that the polycyclic aromatic hydrocarbons do not constitute normal metabolic products but may reach these organisms accidentally. The possibility of tarry materials, from ships or submarine oil wells, being carried to the filter-feeding intertidal sedentary animals constitutes a potential external source for aromatic polycyclic hydrocarbons. We may also mention that the wooden pilings from which the material was collected at Corona del Mar, Calif., had been given a surface creosoting 10 years previously.

It has been observed that the goose barnacle (*Mitella polymerus*), collected from another habitat (on and among the mussels growing on the pier pilings at the Scripps Institution of Oceanography, La Jolla, Calif.), also yielded a fluorescent fraction whose extinction curve was indicative for the presence of 3,4-benzpyrene, although the quantity of this fraction was at least 10 times less than mentioned above. In contrast, our fluorescing fractions from *Tetracita squamosa rubescens*, originating from rocks near La Jolla, were found to be of different nature and free of benzpyrene or similar compounds.

A detailed report on the isolation and characterization of polycyclic aromatic substances from barnacles will be given elsewhere.

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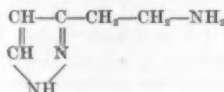
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An Analog of Histamine that Stimulates Gastric Acid Secretion without other Actions of Histamine

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During a survey of the stimulatory and inhibitory actions of chemical analogs of histamine on gastric secretion, one compound was found that possessed the unique property of stimulating gastric acid secretion without producing any of the other pharmacologic actions of histamine. The compound is 3-(β ethylamine) pyrazole (compound XXIV). Its structural formula is:



It will be seen that this is an isomer of histamine in which the ring has a pyrazole instead of an imidazole configuration. The relationship of the side chain to the $=\text{N}-$ is the same as in histamine. The compound was first synthesized and studied by Lee and Jones (1), who found that it did not contract the isolated guinea pig ileum and that it did not lower blood pressure in cats. In the anesthetized dog we have found compound XXIV to be about 1/700th as potent as histamine in depressing blood pressure.

Compound XXIV stimulates acid secretion in dogs with pouches of the entire stomach when the hydrochloride is administered subcutaneously, intramuscularly, intravenously, or orally. By the subcutaneous route the ED_{50} of the hydrochloride (dose required to produce 50% of the maximal secretory rate) is 8 mg/10 min in comparison with 0.12 mg/10 min for histamine diphosphate. The maximal secretory rate attainable with compound XXIV is the same as with histamine. The pepsin concentration of the juice secreted in response to compound XXIV is not significantly different from that stimulated by histamine.

The hydrochloride of compound XXIV has been injected into 20 human subjects by the subcutaneous and intramuscular routes in doses of 10-50 mg. In no instance have any of the characteristic side effects of histamine been observed, including triple response at site of injection, headache, or flush. The 50-mg dose

produced a greater output of HCl than 0.01 mg/kg of histamine diphosphate. Doses of 100 mg produce side effects similar to those seen with histamine.

The existence of this histamine analog with specificity for site of action is in keeping with the known differences between the action of histamine on the gastric glands and its action at other sites. These include (a) failure of antihistaminic drugs to counteract action of histamine on gastric glands, and (b) inhibition by xanthine alkaloids of actions of histamine at other sites but potentiation of the gastric secretory action.

Compound XXIV may prove useful for routine clinical testing for achlorhydria, not only because it would eliminate the undesirable side reactions that follow histamine, but also because it would be possible to produce stronger stimulation of acid secretion and thus provide more clear-cut results in borderline cases. It may also prove useful for the investigation of the maximal secretory capacity of the human stomach in health and disease.

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Recovery of Tumor Cells from Effects of the Tumor-inducing Principle in Crown Gall

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When the tumor-inducing principle associated with the crown-gall bacterium acts on cells of plant species such as *Helianthus annuus* (1) and *Vinca rosea* (2,3), an abrupt and irreversible change in the behavior of these cells occurs. Following the transformation process, proliferation of the altered host cells becomes an automatic process that is independent of the inciting bacteria. The cells of the resulting neoplasm are characterized by excessive powers of proliferation and limited powers of differentiation. Competence for organization appears to have been lost as a result of the action of the tumor-inducing principle. Tumor cells of this type are transplantable, and when bacteria-free fragments are implanted into a healthy host they develop into typical uncoordinated crown-gall tumors.

When, on the other hand, this same tumorigenic principle acts on cells located close to the top of a plant species such as *Kalanchoe daigremontiana*, the altered cells appear at first to be of an undifferentiated type. As the tumors grow, however, there results, in place of the characteristic neoplasm, an overgrowth composed not only of uncoordinated tumor cells but of cells that are organized into morphologically complex structures (4). The question as to whether these structures result from the growth of normal cells that have been stimulated to develop by the expanding tumor, or whether the morphologically abnormal shoots are composed of altered cells that have acquired a ca-

capacity for differentiation and organization, has been a subject for speculation (4-8). It is with this problem and its relation to the recovery of tumor cells that this paper is concerned.

Turkish tobacco (*Nicotiana tabacum*), which responded to bacterial inoculation as did *Kalanchoe*, was used as the test object in these investigations. The plants were grown in 4- or 6-in. pots. When they reached a height of 8-12 in., a single cut was made with a sharp razor through an internode close to the top of the plants. Bacterial inoculations of the freshly cut stem surfaces were made with the T-37 strain of the crown-gall bacterium. The inoculated areas were covered for several days with a rubber tape known as "Sterilastic" to prevent drying.

After a suitable incubation period undifferentiated tumors developed in the region of the cambium. As the tumors expanded, small areas of organized tissue that later developed into teratological structures appeared on their surfaces. Thereafter, the new growth developed rapidly into moderate to large complex overgrowths of a character similar to those previously described as developing on this host (9), on *Kalanchoe* (4), and on certain other plant species (7, 8).

Early in the study of the growth patterns of normal and tumor cells *in vitro* it was observed that, although bacteria-free sunflower tumor cells grew rapidly and in a completely uncoordinated manner on White's medium, normal tissue isolated from the same host developed very slowly on this medium (1).

The growth habits of normal cells, crown-gall tumor cells, and cells isolated from the teratological structures that developed from the complex overgrowths on tobacco were studied *in vitro*. More than 200 fragments of normal tobacco tissue were isolated from newly formed as well as from somewhat older axillary and adventitious shoots, from internodes of young and mature stems, from the region of petiolar attachment as well as from immature tissue just below the developing tip, and were planted on White's medium. The normal tissue fragments themselves increased in volume only slightly in a 12-week period. Adventitious buds that developed from many of these fragments frequently grew into small but otherwise normal-appearing plantlets. Bacteria-free tobacco tumor cells, on the other hand, grew rapidly and in a completely uncoordinated manner on White's medium. This culture medium appeared suitable, therefore, for differentiating normal cells from crown-gall tumor cells of tobacco.

Fragments of tissue were removed aseptically from morphologically distorted but organized stem tissues that developed from the teratomata and were planted on the culture medium. The rate of growth of these bacteria-free tissue fragments, although somewhat slower than that of true tumors, was nevertheless far greater than the rate of growth of normal tobacco cells. These cells differed from the tobacco tumor cells studied in the past, however, in that they possessed a well-developed capacity for differentiation and organ-

ization. Large areas of the surfaces of the cultures were covered with small adventitious buds and leaves that showed varying degrees of structural development. Some buds appeared quite normal, whereas others were highly distorted. The buds never developed appreciably in culture. Roots were not formed. Histologically the cellular mass was composed of a firm core of disorganized hypertrophied and hyperplastic parenchymatous cells. Areas of organization arose for the most part at the edges of the growth. Attempts to isolate fragments from these masses that would develop in culture in a completely undifferentiated and unorganized manner have thus far failed. One clone of this tissue has now been maintained in culture for 16 months. Other clones isolated from different teratological structures have been cultured for shorter periods. The tissues were divided at 6- to 8-week intervals and planted on fresh media. In all instances these cells have maintained their characteristic properties unaltered. It thus appears that the morphologically distorted but organized stems that develop from the teratomata are composed of cells whose metabolism is fundamentally different from that found in normal tobacco cells isolated from comparable but normal stem segments.

When fragments of these abnormal tissues that had been carried in culture for more than 10 months were implanted in healthy hosts, they developed into teratomatous overgrowths that reached a diameter of about 1 cm in a 6- to 8-week period. In their ability to grow profusely on a medium free of added growth substances and in their ability to develop independently of the growth-restraining influences of the host, these cells resemble crown-gall tumor cells of the type previously described. These tumor cells differ from those isolated and studied in the past in that they retain indefinitely *in vitro* and *in situ* a well-developed capacity for organizing leaves and buds.

It has been demonstrated (10, 11) that certain self-duplicating cytoplasmic entities can be eliminated from cells under conditions that favor the increased multiplication of those cells relative to that of the self-duplicating factor. Such entities have been postulated (12) as being responsible for the continued abnormal proliferation of crown-gall tumor cells.

Rapid multiplication of plant cells can be effectively encouraged by forcing the growth of a bud. The meristematic cells of an actively growing bud divide with far greater frequency than do most crown-gall tumor cells. Since it has been demonstrated that certain crown-gall tumor cells retain a capacity for organizing buds, it seemed possible to test the hypothesis indicated above. In order to induce a maximum stimulus for regeneration in the host, all normally produced axillary buds were removed from tobacco plants that had been inoculated at the cut stem surface with crown-gall bacteria. This resulted in the production of a complex tumor that contained adventitious buds composed of tumor cells. When these buds produced shoots large enough to be used as scions, the shoots were removed and grafted to

healthy tobacco plants from which again all normal buds had been removed. It should be recalled that these shoots were composed of tumor cells and, hence, were organized tumors. The new growth that resulted from these rapidly growing shoots gradually became more and more normal in appearance. The tips of the shoots were again removed and grafted to healthy plants. They developed rapidly and appeared normal in every respect, ultimately flowered, and set seed. Fragments of tissue isolated from the normal-appearing stems derived from tumor tissue buds grew poorly in culture, as does healthy tobacco tissue. In these instances recovery appeared to have been complete. It was a gradual process that progressed in the direction of the normal as affected shoots developed and were forced into rapid growth.

Our findings suggest that the factor which causes crown-gall tumor cells to develop abnormally becomes diluted in, and is eventually lost from, affected cells that are forced to grow and divide with sufficient rapidity. Details will be published elsewhere.

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Structural and Insecticidal Relationships in Rotenone, Methoxychlor, and DDT

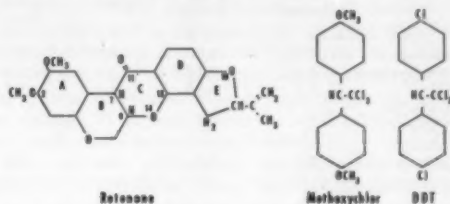
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In the course of investigating the relationship of chemical structure to insecticidal activity, molecular models of known insecticides were constructed, using Fisher-Hirschfelder-Taylor atom models. In this way an interesting structural similarity among rotenone,

DDT,¹ and methoxychlor² was encountered. This similarity is not at all obvious without the use of the models.

Fig. 1 shows the molecular models of rotenone, methoxychlor, and DDT. The configuration of rotenone, (1) shown is *cis* at the 7-8 bond. The structural formulas of these compounds are:



La Forge *et al.* (2) have discussed a series of reactions of rotenone involving hydrolysis of the 13-14 bond followed by oxime formation and ring closure with a nitrogen between the 11 and the 14 positions. Study of the models indicates that this ring closure is strongly hindered sterically for the *trans* position and can be effectuated readily only if the configuration is *cis* at the 7-8 bond. Moreover, the ease of dehydrogenation of rotenone at the 7-8 bond would also seem to indicate that the configuration of the natural product is *cis*.

For the three molecules pictured in Fig. 1, the notable points of similarity are the angles of intersection of the axes of the benzenoid rings and the comparable slopes of the planes of these rings. In rotenone the benzenoid rings are essentially fixed with relation to each other, because of the interconnecting ring structures. In DDT and methoxychlor also, steric hindrance by the trichloromethyl group restricts the benzene rings to a relatively fixed position. In general one of the rings will be quite fixed, whereas the other may oscillate but not perform a complete, free rotation. The configuration of DDT and methoxychlor shown in the figure is, of course, only one phase in the oscillatory movements of these molecules. The rotation-hindering trichloromethyl group forms a "bump" on the molecule which coincides with a similar "bump" in the rotenone molecule resulting from puckering of ring B.

Further comparison of the molecular models indicates a close correspondence in intramolecular distances in these three substances. For example, the distance between the oxygens at positions 2 and 19 in rotenone is very close to the distance between the 2 methoxyl oxygens in methoxychlor and between the *p*, *p'* chlorines in DDT. The models are made to approximate scale, and these distances correspond to within 1 Å. It is interesting to note that, regardless of rotation or oscillation in the DDT-type molecule, the distance between atoms in the *p*, *p'* positions remains constant. The importance of such molecular

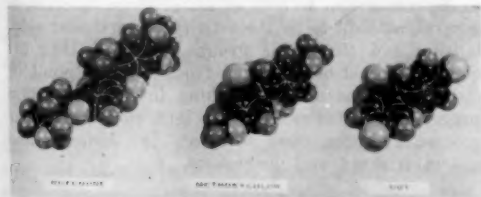


FIG. 1. Molecular models of rotenone, methoxychlor, and DDT.

¹ 1,1,1-Trichloro-2,2-bis(*p*-chlorophenyl) ethane.

² 1,1,1-Trichloro-2,2-bis(*p*-methoxyphenyl) ethane.

TABLE 1
INSECTICIDAL TOXICITY OF ROTENONE,
METHOXYCHLOR, AND DDT

Toxicant	Minimum 100% L ₅₀ (Lbs of toxicant/100 gal water)			
	Mexican bean beetle	Southern army worm	Bean aphid	Two- spotted spider mite
Rotenone	0.12	3.0	> 3.0	> 3.0
Methoxychlor	0.25	0.12	> 3.0	> 3.0
DDT	0.5	0.06	> 3.0	> 3.0
1,1-Bis(<i>p</i> -chlorophenyl) ethane	3.0	> 3.0	3.0	2.0

shape factors in reactions between biologically active molecules and proteins such as enzymes has been widely emphasized (Pauling [3] and Sexton [4]).

To give a mechanistic view, it may be visualized that rotenone "fits" in a lock-and-key relationship with some essential region of the polypeptide chain of an enzyme. The toxicant would be held in position by short-range forces such as van der Waals, dipole-dipole, or hydrogen bonding forces. DDT and methoxychlor can assume a position in which a number of functional groups in these molecules, including corresponding polar and hydrogen bond acceptor groups, are superposable on the rotenone structure. This seems to provide a logical basis for the insecticidal relationship discussed below. In addition to the above-mentioned structural features, these three compounds fall within a limited range (345-394) of molecular weight. The significance of this property has been discussed by Kenaga (5).

A marked parallelism in specificity of insecticidal action, as well as in structure, is noted among rotenone, methoxychlor, and DDT. This similarity is shown by testing the insecticides simultaneously under identical test conditions.

Cranberry bean plants were dipped in the insecticidal dispersions and then infested with third instar larvae of the Mexican bean beetle, *Epilachna varivestis* Muls., and third instar larvae of the Southern army worm, *Prodenia eridania* Cram., respectively, 1 hr after application of the toxicants. Cranberry bean plants and nasturtiums previously infested with adults of the two-spotted spider mite, *Tetranychus bimaculatus* Harvey, and adults and nymphs of the bean aphid, *Aphis fabae* Scop., respectively, were dipped in the dispersions. Insect mortality counts were taken 3-6 days after application of the toxicant and corrected for natural mortality by the use of Abbott's formula.

The insecticidal formulations used were wettable solid dispersions similar to commercial formulations of these insecticides.

A comparison of the toxicity of rotenone, methoxychlor, and DDT to 4 representative agricultural pests is shown in Table 1. These compounds display

a marked similarity in that they are toxic to the same species of insects and ineffective against the same species. Methoxychlor is intermediate between rotenone and DDT in toxicity to Mexican bean beetle and Southern army worm, as it is in structural characteristics. Under the conditions of these tests, residual insecticides are usually the only toxicants that are effective against Southern army worm larvae. Rotenone is quite easily oxidized and therefore not as residual as DDT and methoxychlor. This may offer an explanation for the large break in toxicity against the Southern army worm. 1,1-Bis(*p*-chlorophenyl) ethane, which lacks the sterically restrictive trichloromethyl group contained by DDT and methoxychlor, is included for comparison. It shows a marked change in specificity and strikingly less toxicity against Southern army worm and Mexican bean beetle.

The relationship of structure to insecticidal activity may be illustrated by making a comparison of several compounds related to rotenone. Dehydrorotenone differs from rotenone by the dehydrogenation of the 7-8 bond, thus causing the molecule to flatten out and lose the typical angular relationship between benzene rings. Dehydrorotenone has essentially no insecticidal activity in comparison with rotenone, according to Shepard and Campbell (6). On the other hand, alteration of the isopropenyl side chain (off ring E) by saturation or removal of the groups causes no change in this angle. The resulting compounds, dihydrorotenone and elliptone, in insecticidal tests by Shepard and Campbell (6) and by Martin (7) show comparatively little change in activity from rotenone.

Since the oxidation (dehydrogenation) at the 7-8 bond in rotenone takes place with relatively mild oxidizing agents, this may explain the loss of activity on oxidation in field use. Another property that may prevent rotenone from being residual is hydrolysis at the 13-14 bond, which opens up ring C and destroys the locked ring structure completely.

All compounds containing 2 benzene rings linked through a saturated carbon atom will have nearly the same bond angle, and therefore the rings will be on the same axes; however, the lack of the trichloromethyl group in 1,1 bis(*p*-chlorophenyl) ethane allows considerably more freedom in the rotation and oscillation of the benzene rings and does not fix the rings in restricted planes as it does in DDT and methoxychlor.

Hoskins and Craig (8) and Metcalf (9) have reviewed several theories on the relation of structure to the insecticidal activity of DDT. These theories, in general, attempt to tie the activity to particular solubilizing and toxophoric groups. We feel that the question should be evaluated from the standpoint of the molecule as a whole, taking into consideration properties such as molecular weight, solubility, polar groups, hydrogen bond acceptors (or donors), and molecular shape and dimensions.

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Results of a Preliminary Survey of Group Endings in Zoological Classifications above the Category of Genus

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Late in 1948 the author inquired of 27 North American ichthyologists in regard to fixing specific endings for various categories of classification. Replies were favorable. In order to obtain information on a broader basis, during the early part of 1949 specialists in the fields of carcinology, entomology, herpetology, ichthyology, invertebrate zoology, malacology, ornithology,

numerically, entomologists nearly equal the number of specialists in all other fields together, it was decided to follow the endings as already used by entomologists from superfamily down through subtribe, but to follow ornithologists for the ending of an order (-iformes) and for suborder (-oidei) as used by certain vertebrate zoologists, both minorities, for the purpose of stirring up discussions and inviting comments. The results were interesting and valuable.

The author sent a circular letter to more than 700 North American systematic zoologists on the mailing list of the Society of Systematic Zoology and received 445 ballots in return. This circular proposed to fix the endings of groups above the level of the genus, and results were as shown in Table 1.

The following information was summarized from comments received on about half of the ballots returned: "A wonderful idea and attempt to advance stability [uniformity] of zoological nomenclature;" "Leave nomenclature alone and get back to the study of specimens."

Order -iformes: "Too long; not widely used; preferable not to disturb ordinal and subordinal endings in such groups as entomology, mammalogy, and herpetology since these are so well known they are already fixed by usage; ordinal names should not be

TABLE 1
NUMBER OF VOTES CAST CONCERNING PROPOSED ENDINGS USED IN GROUPS OF CLASSIFICATION

Field	Votes	Order -iformes	Sub-order -oidei	Super-family -oiden	Super-tribe -idi	Tribe -ini	Sub-tribe -ina	Type genus	Unanimous ballots	Total ballots returned*
Carcinology	For	12	17	19	18	19	19	16	11	23
	Against	11	6	4	5	4	4	7	2	
Entomology	For	51	73	153	140	154	127	80	41	159
	Against	106	84	3	13	4	15	68	2	
Herpetology	For	24	24	29	26	27	26	19	17	30
	Against	5	6	—	2	1	2	8	—	
Ichthyology	For	37	39	39	38	39	38	38	32	41
	Against	3	2	1	1	1	1	1	—	
Invertebrate zoology	For	30	31	36	38	38	37	30	25	50
	Against	12	17	12	9	9	10	12	7	
Malacology	For	10	11	16	13	13	13	10	7	17
	Against	7	6	1	3	3	3	7	—	
Ornithology	For	25	21	25	21	22	21	15	13	25
	Against	—	4	—	2	1	2	9	—	
Mammalogy	For	18	28	35	29	30	32	26	16	36
	Against	18	6	—	5	4	2	9	—	
Paleontology	For	10	10	20	19	17	14	12	7	29
	Against	17	17	7	8	10	13	15	5	
Parasitology	For	29	33	34	31	33	31	29	24	35
	Against	6	2	1	3	2	3	5	—	
Totals	For	246	287	408	373	392	358	275	193	445
	Against	185	150	29	51	39	55	141	16	
Grand total		431	437	437	424	431	413	416	209	
Percentage	For	57.1	65.7	93.3	88.0	91.0	86.7	66.1		
	Against	42.9	34.3	6.7	12.0	9.0	13.3	33.9		

* Some ballots did not have votes on every item.

mammalogy, paleontology, and parasitology were consulted. Entomologists and ornithologists have, to a certain extent, already adopted endings for various groups of classification. After discussions with about 20 specialists in the various fields, and knowing that,

changed except for reasons of concept; let each group of specialists for each class of animals decide for itself what ending should be used." *Suborder*: Little or no comment. *Superfamily*: Little or no comment. *Supertribe*, *tribe*, *subtribe*: These categories are used

in the most complicated groups of species, mostly in insects, fishes, and crustacea. Some individuals voted against these categories because they did not use or need them in their own specialty. A sizable majority wants the endings for these categories fixed for all time. The late Mary Rathbun in crustaceans was the only one mentioned as using these groups above the family level.

The following is a summary of nomenclatorial comments on group endings: (1) "Against retroactive action, basic idea stability, not uniformity; (2) *-idi* and *-ini* too much like *-idae* and *-inae* in sound when pronounced; (3) *-ina* and *-ini* conflict when same ending occurs for a genus; (4) endings of higher categories should be selected grammatically." (5) *Unanimous against* in Table 1, 16 ballots, indicates disapproval of any change and a misunderstanding of the type-genus concept. Several of the *unanimous against* ballots came from individuals who had worked in a narrow specialty for a long time. (6) *Unanimous for* in Table 1, 193 ballots, indicates a willingness to go along with any change that will stabilize nomenclature, and they think that the type-genus concept can be worked out with a great contribution toward uniformity, including superfamily, but not above that category. (7) "Advantageous to have characteristic fixed endings for each category of classification of animals, and stabilize names all the way down from Kingdom." (8) "Let law of priority fix all cases; discard all official lists." (9) "Premature action, lack of polling zoologists, and lack of effective conservanda system have invalidated whole present code of zoological nomenclature; new rules are a bar to progress."

Somewhat as an afterthought the idea of a type genus was added to the circular letter. The presentation was too short and not clearly stated; it was therefore misunderstood by a sizable percentage of systematists, who did not distinguish the type-genus concept from the entirely separate concept of uniformity of group endings. In spite of the obvious confusion, 66.1% would fix a type genus through the superfamily. The following is a summary of comments in regard to the type genus concept: (1) "Establishment of type genus for superfamily or any category below superfamily constitutes establishment of type genus for all lower categories to which it belongs zoologically." (2) Each type genus serving as the stem for group names should be selected on basis of: (a) family of world-wide distribution; (b) known in all lands, common, important, famous; (c) typical of the order or group; (d) recent, if possible, then fossil; (e) priority alone not to be considered except in case of controversy; (f) committee of 11 specialists should represent each class and be international in scope, not more than two members from each country, and subcommittees set up for orders or families if desirable; (g) type genus must not be based on a homonym. (3) Should follow law of priority. (4) Group names should be based on older names instead of selecting new ones. (5) For each class print a

tentative list and distribute to all working systematists in each class; five years later reprint with all corrections, after which date this becomes the *official list* and fixes all group names. (6) Use synonyms of a valid genus for family names if already in wide use; (7) Fixing of the genotype has cleared up most genera, and it would do so for families and tribes. (8) Genotype for type genus should be (a) illustrated, based on oldest included genus, following concept of first revision; (b) all decisions to be based on already established nomenclatorial rules.

The results of this survey were presented at the June 1950 scientific meeting (AAAS, Western Division) in Salt Lake City, and several zoologists urged that an extensive international survey should be undertaken on a basis of revised endings, which are herein outlined. The author, on February 21, 1950, presented the results of the survey to the Nomenclatorial Discussion Group in Washington, D. C., and a committee was appointed with the author as chairman for the purpose of investigating the matter further. The following representatives of the major fields listed above acted on the committee: F. A. Chace, B. G. Chitwood, G. A. Cooper, H. M. Friedman, E. R. Hall, D. H. Johnson, E. A. Lachner, R. C. Moore, H. A. Rehder, E. G. Reinhard, C. W. Sabrosky, H. B. Stenzel, and W. Stickle.

Various endings for categories above genus have been proposed and considered by the above-listed committee and again by about 40 systematic zoologists at Salt Lake City in June 1950 (Table 2).

TABLE 2

	AAAS Pearce Committee	B. G. Chitwood	J. W. Durham and H. C. Moore	L. P. Schulz	H. B. Stenzel
Order	{ super -ida main -ida -ida sub -ina -ina }	{ -ida -ida -ina }	{ -ida -ida -ina }	{ -ica -iformes -ida -oidei -ina }	{ neuter -ina -ina }
Family	{ super main sub }	{ -oidea -oidae -idae -idae -inae -inae }	{ -oidea -oidae -idae -idae -inae -inae }	{ -iene -idae -inae }	{ femi- nine -ine }
Tribe	{ super main sub }	{ -idi -idi -ini }	{ -idi -idi -ina }	{ -ici -idi -ini }	{ mascu- line -ine }

The most logical system of endings was proposed by H. B. Stenzel (*Science*, 112, 94 [1950]). Stenzel's plan of endings is logical and aids memory by having two letters of each ending repeated in each comparable group: super-, main-, and sub-. A further memory aid is the suggested use of the neuter, *-a*, for endings of superorder, order, and suborder; feminine, *-ae*, for superfamily, family, and subfamily; and masculine, *-i*, for endings of supertribe, tribe, and subtribe. These endings are short and conform closely to the endings for family and subfamily already adopted in zoological nomenclature. Ichthyologists at the meeting

of the American Society of Ichthyologists and Herpetologists on June 22, 1950, at Salt Lake City voted unanimously to follow the Stenzel system of endings as proposed.

Since there was a very definite opinion not to alter endings for orders and suborders in certain fields, but opinion was very strong for fixing uniform endings for superfamily on down through the subtribe, it was recommended by the committee that a new ballot be sent out on a new survey somewhat as follows:

A proposed form of ballot that might be used is herewith presented for comments:

Terminations for superorder, order, and suborder.

(Vote for only one of choices a, b, or c)

- a) I favor adoption of terminations *-iformes* (order) and *-oides* (suborder) ☐
- b) I favor adoption of *-ica* (superorder), *-ida* (order), and *-ina* (suborder) ☐
- c) I prefer to continue use of terminations for order and suborder, which are established in my field, and consequently favor rejection of any scheme of uniform terminations for superorder, order, and suborder, applicable to all animals ☐
- d) I reject a, b, and c, but suggest the following terminations or offer the following comments: ☐

Terminations for superfamily.

(Vote for only one of choices e, f, g, and h)

- e) I favor adoption of *-oidea* (superfamily) ☐
- f) I favor adoption of *-icae* (superfamily) ☐
- g) I favor rejection of any scheme of uniform termination for superfamily ☐
- h) I favor rejection of both *-oidea* and *-icae*, but suggest the following termination for superfamily or offer the following comments: ☐

Terminations for supertribe, tribe, and subtribe.

(Vote for only one of choices i, j, k, and l)

- i) I favor adoption of *-idi* (supertribe), *-ini* (tribe) and *-ini* (subtribe) ☐
- j) I favor adoption of *-ici* (supertribe), *-idi* (tribe) and *-ini* (subtribe) ☐
- k) I favor rejection of any scheme of uniform terminations for supertribe, tribe, and subtribe ☐
- l) I reject i, j, and k, but suggest following terminations or offer following comments: ☐

Before further plans are formulated for an extensive international survey in regard to fixation of endings of various categories of classification, the author welcomes comments. Should sufficient interest develop in this matter among systematic zoologists and applied or economic zoologists, an attempt will be made to survey the field.

Finally, the author expresses his thanks to all of those who aided in the preliminary survey, especially for the numerous constructive comments.

The Fungicidal and Nematicidal Properties of Dibromobutene

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The importance of the C₃ and C₄ unsaturated halides as soil fumigants has been amply illustrated by reports in the literature of the nematicidal properties of dichloropropene-dichloropropane mixture (1) and dichlorobutene (2), and the fungicidal as well as nematicidal effects of allyl bromide (3) and chlorobromopropene (4). All these materials are liquids possessing relatively high vapor pressures. Consequently their use is confined to application by sub-surface injection, since it is difficult to obtain a biocidal concentration of vapor by surface application. When injected, they are generally effective only below the surface 2-in. zone if but one injection is made. It is possible to disinfest the surface zone only by turning the surface soil under after one injection and applying a second.

Since a double injection procedure, although effective, is time-consuming and increases the expense of fumigation, a search was made for volatile materials that could be applied directly to soil surfaces and that were capable of destroying fungi and nematodes in the upper 2-in. zone. Such a material should have a relatively low vapor pressure (when compared with the liquid fumigants) and for ease in distribution should preferably, although not necessarily, be a solid. Since organisms such as *Rhizoctonia solani*, *Phytophthora* spp., *Pythium* spp., and to some extent *Sclerotinia* spp. and *Sclerotium rolfsii*, characteristically attack in the upper 2-in. zone, the need for a soil surface disinfestant is apparent.

It is the purpose of this paper to report the finding of a material that appears to have considerable promise as a surface-zone fungicidal and nematicidal fumigant. This chemical is *trans*-1,4-dibromobutene-2. It is a white crystalline solid (bp, approximately 205° C; mp, 54° C).

For early experimental tests dibromobutene was formulated either as a dust at 10%w and 20%w in talc for tests in soil, or used directly in laboratory trials by dissolving the chemical in isooctane, acetone, or similar diluents. In preliminary screening trials, in closed glass containers, the fumigant was lethal to conidia and mycelium of *Fusarium solani pisi* and *Verticillium albo-atrum* at .002 g/l of space following an exposure of 24 hr at 21° C.

Because of the number of tests conducted in soil, and their varied nature, a summary is presented in which the fungicidal and nematicidal dosage levels are indicated (Table 1). No soil seals of any type were employed in these tests. In trials using crocks, soil was mixed with the formulated chemical in a rotating drum. For field or greenhouse soil-surface treatments,

TABLE 1
SUMMARY OF FUNGICIDAL AND NEMATOCIDAL DOSAGE LEVEL RANGES FOR *trans*-1,4-DIBROMOBUTENE-2*
IN FRESNO SANDY LOAM SOIL (MOISTURE EQUIVALENT 8.0-10.0%)

Pathogen	Control criterion	Dosage level ranges of dibromobutene within which complete or nearly complete fungicidal or nematocidal control effects were obtained				
		Gallon crocks	Greenhouse benches and ground beds		Field plots	
		Complete soil mix (g/gal of soil)	Surface treatment (g/sq ft)	Complete soil mix (g/cu ft)	Surface treatment (lbs/ac)	Mixed to 6-in. depth (lbs/ac)
<i>Meloidogyne</i> sp.	Root knot on tomatoes	.05-0.2†	> 2.0‡	1.0-2.0†	> 200	> 200
<i>Heterodera schachtii</i>	Infestation of sugar-beet roots	0.2 -0.4†	—	2.0-3.0	—	—
<i>Sclerotium rolfsii</i>	Viability of sclerotia	.07-0.2†	1.0-2.0†	2.0-4.0†	100-200†	150-200†
<i>Pythium ultimum</i>	Damping-off of seedlings	—	0.5-2.0†	0.5-2.0†	50-100	50-100
<i>Rhizoctonia solani</i>	Basal stem rot of beans	—	0.5-1.0†	—	—	—
<i>Fusarium-Pythium</i> complex	Seedling rot and blight of peas	—	—	0.5-3.0	—	—

* Applied as a 10-20% w dust in talc. Dosage levels are given in g or lbs of active ingredient.

† Complete control or complete fungicidal and nematocidal effect in range.

‡ > indicates inadequate to no control at highest dosage used.

the chemical was spread with a garden rake, and for deeper applications in the field an Ariens-Tiller was employed.

In some instances fungicidal effects were determined by plating out exposed fungal spores and mycelium, but in the majority of cases control effects were measured by freedom of disease shown by host test plants. Table 1, therefore, summarizes briefly the results of numerous trials to determine the effectiveness of *trans*-1,4-dibromobutene-2 as a soil fumigant.

In tests on *Heterodera schachtii*, *Meloidogyne* sp., *Pythium ultimum*, *Rhizoctonia solani*, and *Fusarium-Pythium* complex, naturally infested field soil was employed. Only in the case of *Sclerotium rolfsii* was the test organism introduced into the soil to be fumigated.

Failure to control the root knot nematode in field tests is felt to be due to inadequate means of mixing the dust to an effective depth in the soil. This appears to be essential, since the diffusion pattern of *trans*-1,4-dibromobutene-2 in the soil is indicated to be small (2-3 in. radius).

In addition to good disease-control effects when mixed in the soil as a formulated dust in the absence of a seal, it was noted that at fungicidal levels the chemical was not particularly toxic to crop seeds provided water was withheld for 24 hr following treatment and planting. In the case of peas and sugar beets this tolerance was outstanding. Excellent stands were obtained at control dosage levels (*Rhizoctonia* and *Pythium*) when seeds were planted at the same time the chemical was applied.

Results to date indicate, therefore, that *trans*-1,4-dibromobutene-2 may be useful as a solid fungicidal and nematocidal soil fumigant. Since mammalian toxicity tests with *trans*-1,4-dibromobutene-2 have not been completed, final appraisal of the toxicity of the

compound cannot be made. However, present data indicate that the material possesses a high degree of mammalian toxicity by inhalation, ingestion, or skin contact. Fortunately, the material is a lachrymator and therefore produces definite warning symptoms.

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The Equilibrium between Vitamin B₁₂ (Cyanocobalamin) and Cyanide Ion

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Beaven (1) has reported recently the reversible formation of a purple complex of vitamin B₁₂ (cyanocobalamin) with cyanide ion. We also have observed this reaction, and have studied the equilibrium polarographically. Cyanide ion gives a very well-defined diffusion current at the dropping mercury anode in alkaline solutions (2) and thus provides an elegant means for measuring the binding of cyanide by vitamin B₁₂. No free cyanide ion could be detected in solutions of pure cyanocobalamin, and additions of cyanide resulted in further binding to form complexes containing 1 or 2 moles of cyanide in addition to the cyano-group already present in cyanocobalamin.

The procedure was as follows. A standard 0.1 M solution of sodium cyanide in 0.1 M lithium borate

○ CYANIDE ION IN 0.1M LITHIUM BORATE (PH 10.99)
● DITTO + 0.438 MILLIMOLAR VITAMIN B₁₂

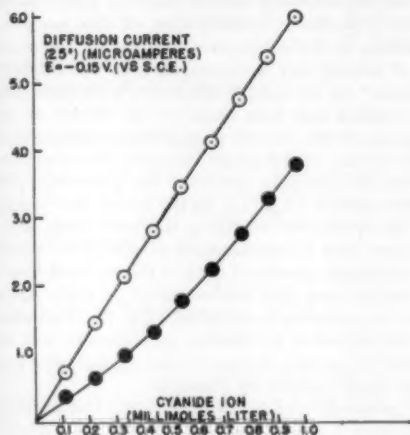


FIG. 1.

buffer, pH 10.99, which was prepared daily from the calculated amount of solid NaCN (purity determined by argentimetric titration), was added in portions from a 0.1-ml Gilmont microburette to an air-free solution of the buffer contained in the polarograph cell at 25°. The polarograph (Leeds & Northrup Electro-Chemograph, Type E) was set at -0.15 v (vs. SCE), and the galvanometer deflection was recorded for each addition. The measurement was then repeated with a similar solution made up to contain also 0.438 mM/l of vitamin B₁₂ (a twice-recrystallized sample, purity better than 99%, dry basis) the molecular weight being assumed to be 1,350. A graph of cyanide ion concentration, corrected for hydrolysis, versus diffusion current was prepared, and from this the amount of cyanide ion in equilibrium with vitamin B₁₂ and the complex at each level was computed. The results are given in Fig. 1 and Table 1.

TABLE 1
BINDING OF CYANIDE ION BY VITAMIN B₁₂
(All Concentrations in mM/l)

Vitamin B ₁₂	Cyanide added	Free cyanide
0.438	0.110	0.041
.438	.219	.090
.437	.328	.145
.436	.436	.199
.436	.545	.269
.435	.653	.345
.434	.762	.428
.433	.869	.515
0.433	0.976	0.598

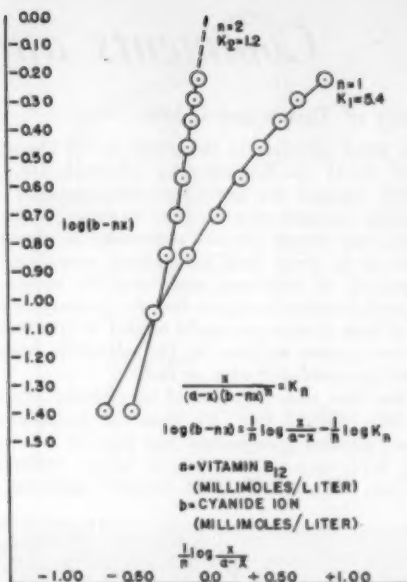


FIG. 2.

It was observed that the reaction between vitamin B₁₂ and cyanide proceeds at a measurable rate at 25°, 10-15 min being required to establish a steady diffusion current after each addition of cyanide. No such lag was noticed when vitamin B₁₂ was absent.

The equilibrium being assumed to be of the type



the reaction is described by the equation

$$\frac{(x)}{(a-x)(b-nx)^n} = K_n$$

where a represents concentration of vitamin B₁₂, b represents cyanide added, and $b-nx$ free cyanide. In earlier experiments with samples of vitamin B₁₂ less pure than that at present employed, a satisfactory constant appeared to be obtained for $n=2$, but this work indicates that the reaction proceeds in two overlapping stages, wherein first one and finally two cyanide ions are bound. Graphs of the function

$$\log(b-nx) = \frac{1}{n} \log \frac{x}{a-x} - \frac{1}{n} \log K_n$$

for $n=1$ and $n=2$ are shown in Fig. 2. The curve for $n=1$ departs from linearity at higher concentrations of cyanide, whereas the reverse is true for the curve of $n=2$. The limiting values of K_1 and K_2 are estimated to be about 5.4 and 1.2, respectively.

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Comments and Communications

Theory of Tastes and Odors

WE WERE interested in the article on "A Theory of Odors" by G. B. Kistiakowsky (*Science*, 112, 154 [1950]) because we have been independently approaching the same problem from an experimental direction. Our results are not sufficiently advanced to enable us to draw final conclusions regarding the mechanisms of taste and smell, but the results we have so far obtained suggest that the primary mechanism of both these senses might be that of interference with one or more enzymes by the substances possessing the properties of odor or taste.

It has been shown by one of us (Bourne, *Nature*, 161, 445 [1948]) that, by Gomori's histochemical method, alkaline phosphatase was present in a relatively high concentration in, or in the epithelium overlying, the taste buds in various mammals. In

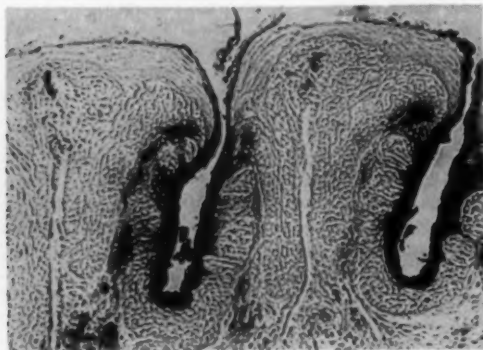


FIG. 1. Alkaline phosphatase reaction in the papilla foliata of the rabbit. The epithelium overlying the taste buds and at the bases of the papillae is seen to be heavily impregnated, indicating a high concentration of the enzyme in this region. Elsewhere there appears to be little phosphatase. ($\times 120$.)

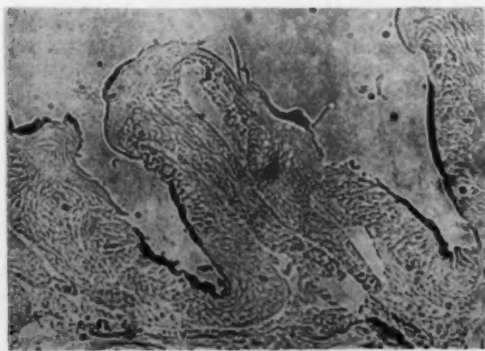


FIG. 2. Alkaline phosphatase reaction in the papilla foliata of the rabbit after adding 0.05% of vanillin to the substrate. Some reaction is still present in the epithelium, but it is greatly reduced. ($\times 120$.)

addition, the olfactory mucosa was also found to contain an appreciable concentration of this enzyme.

Working on the assumption that part of the mechanism of tasting may be associated with the inhibition of this enzyme by various substances with taste properties, studies had been made on the effects of such substances on the Gomori phosphatase reaction in the papilla foliata of the rabbit's tongue. We have found that vanillin strongly inhibited the gustatory phosphatase reaction (Fig. 1). In the rabbit this reaction is in the epithelium overlying the taste buds, and it was found that a concentration of 0.05% of vanillin in the substrate produced quite a strong inhibition of the reaction, and at a concentration of 0.5% the reaction was completely abolished (Fig. 2). Histochemical demonstration of alkaline phosphatase was also inhibited to varying degrees in kidney, gut, and bone, and in nasal mucosa by vanillin.

The substrate used for demonstrating this gustatory phosphatase (or phosphatases) was sodium β -glycerophosphate, but the following substrates have also given positive results: hexose diphosphate, muscle adenylic acid, yeast adenylic acid, and adenosine triphosphate.

The inhibiting effects of vanillin and other substances on the ability of the gustatory phosphatase(s) to split these other substrates have not yet been investigated.

Obvious inhibition of gustatory phosphatase has also been found with infusions of tea and with capicum, but sugar, sodium chloride, and quinine have no effect. Infusions of coffee, oil of aniseed, and oil of peppermint have a slight effect.

In addition to the phosphatase(s), we have also shown histochemically that a simple esterase is present in fairly high concentration in the taste buds and to a much smaller extent in the epithelium of this region of the tongue. There was a fairly high concentration of this esterase also in the neighboring accessory salivary tissue. The enzyme was demonstrated by Gomori's modification of the Nachlas-Seligman method (*J. Natl. Cancer Inst.*, 9, 415 [1949]), which is as yet unpublished.

The histochemical reaction for this esterase is inhibited strongly by quinine but not by sugar or sodium chloride. We have not as yet established whether these inhibitions are true interference with enzyme activity or whether they represent some interference with the histochemical reaction. However, the points we should like to emphasize are:

- 1) We have found in the papilla foliata of the rabbit 2 enzymes (or groups of enzymes) of the 4 groups postulated by Kistiakowsky as being required to explain the mechanism of smell (and presumably also of taste).
- 2) We have found so far that the histochemical reactions of these enzymes (or groups of enzymes) are inhibited by some substances that have a well-defined taste and are not inhibited by others.

We had not intended to publish this work until we had accumulated many more data, but the remarkable coincidence between the experimental results we are obtaining and the theory propounded by Kistiakowsky influenced us to make this preliminary report.

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Cartesian Diver Balance

RECENTLY Smith and Post (1) published a paper entitled "Improved Technique for Weighing Tissues with the Cartesian Diver." The authors employed the formula of Zeuthen (2, 3)

$$RW_s = RW_{st} \frac{1 - \frac{B}{B - p_s}}{1 - \frac{B}{B - p_{st}}} \quad (1)$$

in such a way that they inserted in it the directly read equilibrium pressures (p_s and p_{st}) of the diver when loaded with an unknown weight and a known standard. However, in (3) it is stated: "By this procedure the pressure at which the balance neither sinks nor rises in water (the equilibrium pressure, or e.p.) may be measured. The change in equilibrium pressure (p_s) resulting from the loading of the balance with some biological object (RW_s) is compared with the change in e.p. (p_{st}) resulting from the loading of the balance with a known RW (RW_{st}). It seems impossible that "change" could mean anything but the difference in equilibrium pressure between an empty and a loaded balance. Because of this misunderstanding Smith and Post find that the formula (1) gives meaningless results under certain conditions. If the formula is used correctly, the calculations lead to values in good agreement with those obtained by Smith and Post (cf. Table 1). We cannot, of course, explain the relatively large deviations between actual RW and RW measured on their diver balance. For better results (in the μ -range), see (4).

Smith and Post introduce two new formulas concerning which we wish to make a few comments. First, a simple calculation shows that they are identical. In spite of this, Smith and Post arrive at different results when using them. Second, they are not new. Løvtrup (4) has published the same formula in a different form. It reads:

$$RW_s = Z \frac{-\Delta p_s}{p + \Delta p_s} = Z \frac{-\Delta p_s}{B + p_0 + \Delta p_s} \quad (2)$$

The e.p. of the empty diver is p_0 , so that $p_0 + p_s$ is equal to the manometer reading when RW_s is weighed. In Smith and Post's terminology formula (2) reads:

$$RW_s = V_c \frac{p_s - p_0}{B + p_s} \quad (3)$$

which is identical with their formula (6). The diver constant (Z) is equal to the reduced weight of the diver balance proper and therefore equal to the gas

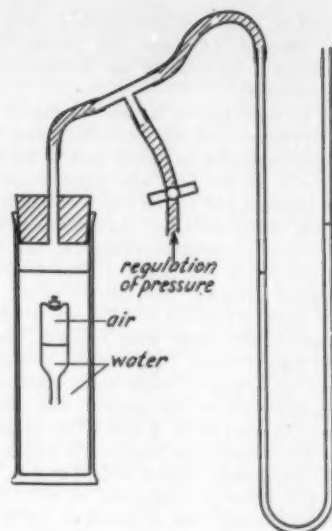


FIG. 1.

volume of the empty diver when the density of the flotation medium is 1. Thus (Z) is identical with V_c in Smith and Post's paper.

At the time of publication of (2, 3) it was still doubtful whether the reduced weight of the diver proper remained absolutely constant. In all cases the empty diver was found to change its e.p. gradually. This could—with a constant RW of the empty submerged diver—be due to loss of gas by diffusion out of the diver. It could also, however, be due to change in RW of the submerged diver proper, caused by unknown factors. Later experimental work (4) has supplied evidence that Z is in fact a constant, thus making the former possibility the more likely one. This forms the basis for the routine use of the convenient diver constant.

When the modified formula was introduced, it was expressly stated that formula (1) does not lead to wrong results, but the new formula (2) makes it possible to simplify both the weighing procedure and the calculations. The constant Z is found by loading the diver with a known standard, and standardization is carried out only occasionally; previously this was done between each short series of measurements of the biological samples.

Concerning the conditions of the experiments, Smith and Post violate a number of rules that we consider imperative, and that are published in (3). For example, air bubbles on the outside of the diver should never be tolerated. They can easily be avoided if the basic physical principles for the solubility of gases in water are considered. The diver should never be used at pressures very different from 1 atm to avoid air bubbles on the outside of the diver, especially at very low pressures. Neither standards nor

tissues should be shaken off the balance. They should be gently removed (we use the Holter braking pipettes), because currents in the flotation medium should be minimized.

It would be unfortunate if this discussion should leave the impression that the Cartesian diver balance is exceedingly unreliable to handle and to work with. For the benefit of the few who have trouble with giant diver balances and of the many who have never heard of such instruments, we shall conclude by discussing a simple experiment (Fig. 1). We took a Carlsberg beer bottle and made it float bottom upward in a glass cylinder. The volume of air in the bottle in the floating position was 214 ml. Air bubbles on the outside of the bottle were avoided. The glass cylinder was tightly closed with a rubber stopper into which tubing leading to a water manometer was inserted. The pressure in the system was regulated through the side arm of a T-tube. The equilibrium pressure of the "diver" was read while empty, while loaded with 1 g, empty, loaded with 2 g, etc., as explained in (3) although misquoted in (1). With a 10-g laboratory weight as a standard (*RW* arbitrarily put = 1) and using formula (1), we found the relative *RW*'s of a 5-g, a 2-g, and a 1-g weight to be 0.508, 0.198, and 0.100, respectively. This experiment was carried out in the crudest possible way. It is hoped that the relatively good results will appear encouraging. A 0.2-ml bottle will weigh *RW*'s in the mg-range just as easily.

TABLE 1*

<i>RW_{st}</i> (mg)	<i>RW_s</i> (mg)	Change in manometer reading (cm Brodie)		<i>RW_s</i> (mg) calculated after	
		<i>P_{st}</i>	<i>P_s</i>	Smith and Post	Zeuthen
6.3	17.2	26.3	74.2	18.7	18.6
8.6	4.8	35.0	20.6	5.0	5.0
8.6	4.8	36.3	20.8	4.8	4.8
0.381	0.89	77.1	167.9	0.90	0.91
0.381	0.0286	76.1	6.8	0.032	0.031
0.381	0.89	77.8	163.0	0.87	0.88

* In this table *p_{st}* and *p_s* correspond to the numerical change in equilibrium pressure due to loading the balance. In the last example, second group, of Smith and Post (1), the "actual" *RW* is off by a power of 10. This has been corrected in our table.

Smith and Post conclude their paper by expressing the opinion that probably "the simplified method described can be applied to weighing tissues much smaller than embryonic hearts." Since no information is given about their method, the shape of their balances, or other details, it is of course difficult to decide whether they will ever reach this goal by their method. Smith and Post are working in the mg-range, but we have repeatedly shown that weighing of much smaller quantities is possible (3-6). The sensitivity of the diver balance described in (3) is $\pm 0.02 \mu\text{g}$.

This means that $1 \mu\text{g}$ *RW*—the order of *RW* of large amebae—can be weighed with a high percentage of accuracy.

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Isolation of *Histoplasma capsulatum* and *Allescheria Boydii* from Soil

SKIN-TESTING surveys in Williamson County, Tennessee, have shown that more than 70% of the individuals tested with histoplasmin give a positive reaction to that antigen (1). This knowledge prompted the writers to initiate a search for *Histoplasma capsulatum* in the environment of that rural county.

The fungus has been sought in soil by utilizing the following procedure: A heaping teaspoonful of a soil sample is mixed with 30 ml of physiological saline in a 25 × 150 mm test tube. After standing for 1 hr, 5 ml of the supernatant is pipetted off and added to an equal volume of 5% gastric mucin. One-ml aliquots of this mixture are then injected intraperitoneally into each of 4 mice. The mice are sacrificed after 2 weeks, and duplicate tubes of a neutral dextrose-peptone agar are inoculated with portions of each of their livers and spleens. It has been found necessary to give the mice daily injections of a mixture of 1,000 units of streptomycin and 12,500 units of penicillin during the first week, to prevent death by bacteria. This procedure is a modification of one successfully developed by Emmons (2) in the isolation of *H. capsulatum* from soil collected in Virginia. The use of gastric mucin, suggested by the work of Strauss and Kligman (3), and treatment of the mice with antibiotics are the principal changes.

To date, 101 soil samples, collected from 24 farms in Williamson County, have been examined. Soil sample 22C, collected on July 18, 1950, yielded a heavily sporulating strain of *H. capsulatum*, which was recovered from 3 of 4 mice. This represents the first isolation of *H. capsulatum* from any source in Williamson County, despite the apparent heavy prevalence of human infection.

In addition, from soil samples 8E and 23E, collected on July 6, 1950, and July 18, 1950, respectively, two strains of *Allescheria Boydii* have been isolated repeatedly. This fungus is one of the etiologic agents of human mycetomas and, more rarely, of systemic infections. These soil isolations represent its first recovery from an extrahuman source.

Details of these isolations and further studies will be published elsewhere.

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Why Do Insects Have Six Legs?

WITH few exceptions, adults of the several million species of insects reputed to be in existence have three pairs of legs. This implies that this particular number of legs has some very general adaptive significance, or, to put it another way, in the vast majority of insects any deterioration in the genetic complex responsible for the production of three pairs of legs is promptly and effectively selected against.

Why three pairs of legs, and not two? Evidence from comparative morphology of the arthropods supports the concept that insects were derived from many-legged ancestors, perhaps centipede-like in appearance. Presumably the hexapod condition arose by gradual reduction of the number of legs. The reduction went no farther than three pairs, because locomotion on two pairs of legs is not efficient for a small animal encased in an exoskeleton. Normally, the insect walks by lifting two legs on one side and the middle leg on the other, sweeping these forward simultaneously and placing them down together, thus completing a single step. The other three legs furnish a tripod support while the step is taken. The center of gravity shifts out of the base of the tripod near the

end of each step, and the insect falls onto the three legs just placed down. Thus, as the insect walks, it falls from one solid tripod support to another. Maintaining balance is an important problem in locomotion, and the smaller the animal, the more difficult it is. An illustration of one of the principles involved is shown by the ease with which a long stick can be balanced vertically on the end of one's finger, as compared with the difficulty of balancing a pencil. A contributing factor to this is that the pencil falls more quickly than the long stick. A large mammal has a comparatively long time to make the corrections necessary to maintain balance in the more precarious quadrupedal or bipedal locomotion, whereas a small insect has much less time, possibly not enough for nerve-controlled responses to operate. Another important factor in the difficulty of maintaining balance is the relative inflexibility of the trunk of the insect. Mammals can maintain balance by small, extremely varied movements of the trunk, and the even more flexible tail is an important balancing organ in many mammals. Insects can walk with one or two legs destroyed, but locomotion is then a slower and more uncertain process.

There are many aquatic, swimming insects which, as adults, cannot walk. The three pairs of legs invariably present in these forms could be explained on a similar adaptive basis, by assuming that in the terrestrial ancestors of these forms the number of walking legs was stabilized at six, and then that different auxiliary but important functions were assigned to different pairs of legs, such as antennae-cleaning, stridulating, elytra-cleaning, etc. Selection pressure then would operate to retain all three pairs. A similar explanation could be applied to other primarily nonwalking insects.

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Book Reviews

Population Genetics and Animal Improvement: As Illustrated by the Inheritance of Egg Production.
I. Michael Lerner. New York: Cambridge Univ. Press, 1950. 342 pp. \$5.50.

Although the author assumes that the reader has only an elementary knowledge of genetics and statistics, this book is primarily addressed to teachers, investigators, and advanced students of animal genetics. The treatment is nonmathematical. The biometric foundations of the book rest almost wholly on Sewall Wright and Lush and his school. The undercurrent of genetic theory is dominated largely by Mather's concept of polygenic inheritance (i.e., that genes acting on economic traits such as egg production are inherited in the Mendelian manner, but that variation

due to them is small in relation to the total). The author's recent researches in the area of population genetics of egg production provide the principal source of illustrative material. Egg production is taken as the model trait to illustrate the principles of population genetics.

The first 4 of the 15 chapters in the book are introductory in nature. Chapter 2 gives a historical survey of the literature on the inheritance of egg production. The author points out the fallacy of the Mendelian approach which has been used to study the inheritance of egg production. He then sets forth arguments for the newer, more acceptable "polygenic" approach. Chapter 3 is devoted entirely to a biological analysis of egg production in the fowl. The 5 physio-

logical components of egg production originally suggested by Goodale are considered separately, and the logic of their use in setting up a production index (a criterion of selection for egg production and viability) is discussed. In Chapter 4 a description of the University of California flock is given as a case history. This is justified since the author's viewpoints and conclusions are largely based on data gathered from this flock.

Not until Chapter 5 does the author get down to the principal task—development of the subject of population genetics. Six fundamental postulates are listed on which applied population genetics is based. This chapter is also a brief preview of the material covered in subsequent chapters.

Chapters on heritability, principles of selection, and expected genetic gains follow in logical sequence. The reader will find Lerner's treatment of the problem of artificial selection for egg production especially interesting. He alludes to Mather's genetic balance and fitness concept. Under artificial selection genes are not in balance. Concomitantly there is a counterforce of natural selection for genetic balance most favorable to fitness (survival). These forces oppose one another.

The material covered in Chapter 12 on phenotypic and genetic correlations should serve to clear up much of the misunderstanding regarding these. Methods of estimating genetic correlations are discussed. Their use in constructing selection indexes is considered in Chapter 13. Considerable detail is devoted to the principles of constructing selection indexes.

Throughout the book the author points up important problems and suggests ways these might be solved. He classifies and discusses these problems under 6 headings in the last chapter.

A unique feature of organization is an appendix including a list of 44 numbered text formulas, together with a statement of what the formulas are, a glossary of symbols and definitions (8 pp.) and a bibliography and author index (17 pp.).

There is little question but what the book is a valuable contribution to the field of poultry breeding. The degree of success it will meet as a teaching text remains to be seen. Certainly its use would be on a graduate level. Yet the teacher would need to supplement the nonmathematical treatment showing the derivations of at least the most important formulas.

The author perhaps lays more stress on the polygenic aspect of population genetics than is justified. Certainly the consequences are no different than under the older multiple-factor concept of quantitative inheritance. The numerous cross references to which he alludes in this brief work hardly seem necessary, and this reviewer found the frequent interruptions and digressions from the central thought rather bothersome.

On the whole this monograph is well written, and

the author deserves praise for a job well done. His important contributions to the population genetics of poultry and his bringing to focus many of the as yet unsolved problems doubtless will serve to stimulate old workers and recruit new ones to the field of population genetics.

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Learning Theory and Personality Dynamics: Selected Papers. O. Hobart Mowrer. New York: Ronald Press, 1950. 776 pp. \$7.50.

This book contains data and ideas that must interest both the narrowly academic psychologist and the student of literature—from the trainer of animals to the parent who wants to know whether children should be punished or how to stop them from wetting their beds. Eight of the 24 papers are published here for the first time.

Persons interested in theory are likely to use this book with mixed feelings. Mowrer's views have not been static, and their development is evident in these papers. But the method of publishing has forced him into an elaborate set of commentaries on his own earlier writing. It surely could not have cost much more effort to produce a single coherent account of his present position, which would have meant a shorter book and one more easily read. Anything is unfortunate that detracts from a serious consideration of the material presented here.

To understand the book one must realize that Mowrer aims at a synthesis of psychoanalysis with "learning theory," which is a special brand of academic psychology. (He assumes, for example, only the primordial motives of hunger, pain, and sex, an assumption which leads to a completely inadequate account of emotion, in the reviewer's opinion, with disregard of established experimental fact.) By the time he has finished his synthesis, learning theory has become almost unrecognizable, and the analytically inclined may find the same thing true of his psychoanalysis. However, the bridge that Mowrer constructs between animal psychology, based on rigorous experiment, and the very unexperimental study of human clinical problems, represents genuine communication between the two areas, whether one accepts his theoretical ideas or not. This amalgamation is in itself an achievement.

Anyone who has any interest in psychological problems should read the last four or five chapters, including "The Life and Work of Edgar Allan Poe—A Study in Conscience-killing" and "On the Psychology of Talking Birds—A Contribution to Language and Personality Theory."

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News and Notes

Scientists in the News

Recent visitors at the National Bureau of Standards from abroad were **Antoine Craya**, professor of physics at the University of Grenoble; **D. M. McKay**, physicist with Kings College, University of London; **Frank R. Shroff**, professor of oral pathology and bacteriology at the University of Otago, New Zealand; **Knut Gard**, secretary of the Norwegian Dental Association, Oslo; **Neil E. Goldworthy**, director of the Institute of Dental Research in Sydney, Australia; and **Takashi Isobe**, professor, Faculty of Engineering, University of Tokyo.

Progress in the search for plant sources of cortisone has been reported by **Walter Hodge**, on leave from the University of Massachusetts botany staff to assist the federal Bureau of Plant Industry as a plant explorer in South Africa. Dr. Hodge has just returned from the Rhodesias, Nyasaland, and Tanganyika and will next work north of Capetown in Namaland.

Sverre Tore Hocl, of Lunderseter, Norway, and **Tore Gaute Aas**, of Eidsvold, Norway, have arrived in the U. S. to spend a year studying timber production methods. Arrangements for the one-year work visit to this country were made by the American Forestry Association and the Norwegian Embassy with the Weyerhaeuser Timber Co., Tacoma, Wash., and the Southland Paper Mills, Lufkin, Texas.

Erik Holmberg, of the Observatory of Lund, Sweden, has been invited to work for a year at the Mount Wilson and Palomar Observatories. His research will primarily concern stellar systems outside the Milky Way.

Leslie E. Howlett, codirector of the Division of Physics, National Research Council, Ottawa, was Canadian delegate to the Brisbane meeting of the Australian and New Zealand Association for the Advancement of Science, which has just been held in connection with the Jubilee of the founding of the Commonwealth of Australia. Dr. Howlett will also visit scientific institutions in New Zealand, Australia, India, Pakistan, Italy, Denmark, and the United Kingdom.

J. Peter Kass has been appointed director of the Research and Development Department of Atlas Powder Company, Wilmington, Del., succeeding **K. R. Brown**, who was elected vice president of the company.

Raphael G. Kazmann, consulting ground water engineer, of Stuttgart, Ark., has resigned his position as chief hydrologic engineer in charge of investigation and research with Ranney Method Water Supplies to open his own office as consulting ground water engineer.

Vasili I. Komarevsky, professor of chemical engineering and director of the catalysis laboratory at Illinois Institute of Technology, will lecture this month before the Société de Chimie Industrielle, Paris, on "Aromatization of Hydrocarbons." Dr. Komarevsky is an alumnus of Moscow University and has been a staff member of the Moscow Academy of Mines and the Kaiser Wilhelm Institute of Biochemistry in Berlin. He came to the United States in 1930.

Max A. McCall, assistant chief of the Bureau of Plant Industry, Soils, and Agricultural Engineering, has requested voluntary retirement, having served 36 years in the federal service. He plans to continue agricultural activities but without the pressures of official responsibility. In 1950, Dr. McCall was awarded the USDA's Distinguished Service Award for "distinguished service to American agriculture through the planning and execution of outstanding research programs, establishing high standards of research, and inspiring a high degree of excellence among agricultural research scientists."

John A. Nagay has joined the staff of the Manpower Branch, ONR. Following service in the Air Force, Mr. Nagay was connected with the Personnel Research Section of the Adjutant's General's Office, War Department, and then with the American Institute for Research, University of Pittsburgh.

Sherman K. Neuschel, chief of the U. S. Geological Survey's program of mapping the geology of Pacific Islands, conveyed the greetings of William E. Wrather, director of the Survey, at the 58th annual meeting of the Geological Society of Japan at Kyoto. Several other Survey geologists stationed at Tokyo also attended the meetings: **Monta Wing**, of Beloit, Wis.; **Allen Nicol**, of Los Angeles; **Helen Foster**, of Adrian, Mich.; **Arnold C. Mason**, of St. Louis; **Rachel Barker**, of Brattleboro, Vt.; **Betty Moriwaki**, of Chicago; and **Theodore Sumida**, of Sacramento, Calif. The society elected as its president **Ichiro Hayasaka**, for 20 years professor of paleontology and head of the geology faculty at the University of Formosa, and now professor at the University of Hokkaido.

Richard Parmenter has been appointed associate director of the Operations Research Office, which Johns Hopkins University operates for the Department of the Army. Coordinator of research at Cornell University, Dr. Parmenter has been a consultant to the organization for some months. He will devote part time to the assignment. Established in 1948, the Operations Research Office has headquarters at Fort Lesley J. McNair, Washington, and is directed by Ellis Johnson.

E. Claiborne Robins, president of A. H. Robins Co., Inc., of Richmond, Va., was elected to the board of directors of the American Pharmaceutical Manufac-

turers Association during the recent meeting at Boca Raton, Fla. Named also to the board of trustees of the University of Richmond, Mr. Robins is a trustee of the projected Richmond Memorial Community Hospital, and president-elect of the alumni association of the Medical College of Virginia.

J. T. Robinson, chief assistant to the late Robert Broom since 1945, will carry on Dr. Broom's work on ancient man at the Transvaal Museum in Pretoria, S.A.

Lloyd V. Sherwood, of Dayton, Ohio, has been appointed manager of the agricultural chemicals section of Monsanto Chemical Company's Organic Chemicals Division development department. He replaces **Robert W. Towne**, of St. Louis, who has been transferred to The Chemstrand Corporation, a jointly owned subsidiary of Monsanto and American Viscose Corporation. Dr. Sherwood, who has been with Monsanto's Central Research Department at Dayton, will continue temporarily to conduct special field work there on a soil stabilization program.

Donald Slaughter, dean of the University of South Dakota School of Medicine, has been appointed consultant to the postgraduate Army Medical School to lecture on "The Philosophy of Medical History."

Foster Dee Snell, president of Foster D. Snell, Inc., is in Europe to attend the Third World Petroleum Congress being held at The Hague and to visit his firm's associates and clients in France, England, Italy, and The Netherlands.

Eric G. Snyder has been named vice president of Takamine Laboratory, Inc. He joined the organization as director of research in 1949.

Fred L. Soper, director of the Pan American Sanitary Bureau, Regional Office of WHO, has returned from Bogotá, where he conferred with public health authorities regarding plans for international collaboration in the production of yellow-fever vaccine. With Miguel E. Bustamante, secretary general of the Bureau, he also attended the Fourth World Health Assembly in Geneva.

Elvin C. Stakman, chief, Division of Plant Pathology and Botany, University of Minnesota, was recently made a member of the Royal Norwegian Academy of Science of the University of Oslo. Dr. Stakman was appointed to the group of biological scientists.

Charles Allen Thomas has been elected president of Monsanto Chemical Company, succeeding **William McNear Rand**, who has retired in accordance with provisions of the employee pension plan. Mr. Rand has been president since 1945, and Dr. Thomas has been executive vice president since 1947.

Lester A. Wilson, Jr., of Duke University, has been appointed assistant professor of obstetrics and gynecology at the University of Virginia.

Grants and Awards

Antara Products Division of General Dyestuff Corporation has established a fellowship for the study of the function and effectiveness of the surface activity of surfactants in enhancing the lethal power of herbicides, at the Agricultural Experiment Station at Rutgers University.

The **Arthritis and Rheumatism Foundation** is offering research fellowships at both the pre- and post-doctoral levels, ranging from \$1,500 to \$6,000. Deadline for applications is *November 15*. Apply to the medical director of the foundation, 535 Fifth Ave., New York 17.

The **Free Russia Fund, Inc.**, a nonprofit organization, has been established by the Ford Foundation to assist exiles of all Soviet nationalities in their integration into U. S. culture. **George F. Kennan** is president of the fund; **Frank Altschul**, **Philip E. Mosely**, **John E. F. Wood**, and **R. Gordon Wasson** are trustees; and **George Fischer**, of Harvard, is director. Offices are at 542 Fifth Ave., New York.

Grant Fellowships (sponsored by the Grant Foundation, of New York City) in **Family Life Education**, at Cornell, have been given to **Blaine M. Porter**, of Iowa State, and **Elmer M. Knowles**, of the Merrill-Palmer School, Detroit.

For the academic year 1951-52 the **National Research Council of Canada** has granted 215 scholarships valued at a total of \$192,100. Fourteen special scholarships for work at Oxford and London, Caltech, Cambridge, Harvard, Iowa State, Ohio State, and Paris were awarded, and seven overseas postdoctorate fellowships for work at the British universities of Birmingham, Leeds, and Oxford.

The Psychophysiology Branch, Human Resources Division, **Office of Naval Research**, has completed arrangements to extend the following research projects for periods ranging from two to four years, through use of longevity funds: "Cutaneous Medication of Vibratory Forces," **F. A. Geldard**, University of Virginia; "Electrical Activity of Visual Receptors," **H. K. Hartline**, Johns Hopkins; "Chemoreception," **C. Pfaffmann**, and "Electroretinograms," **L. A. Riggs**, Brown University; "Physiological Acoustics and Voice Communication," **S. S. Stevens**, Harvard Psycho-Acoustic Laboratory; "Physiology and Anatomy of the Auditory System," **A. R. Tunturi**, University of Oregon; "Photochemistry of the Retina," **G. Wald**, Harvard; and "Sound Conduction in the Ear," **E. G. Wever**, Princeton.

Continuing a program begun in 1940, the **Western Actuarial Bureau**, acting for the stock fire insurance companies, has awarded 16 four-year scholarships in fire protection engineering at Illinois Institute of Technology, the only educational institution in the country offering a degree in fire protection and safety engineering.

In the Laboratories

The Borden Company's Chemical Division will build a formaldehyde and liquid urea resin manufacturing plant on the outskirts of Demopolis, Ala., where the company has acquired a 20-acre tract of land. Completion of the plant is scheduled for 1952.

Ciba Pharmaceutical Products, Inc., Merck & Co., Inc., Organon, Inc., and Schering Corporation, have completed an agreement covering the manufacture of cortisone, which makes available their patents for manufacture of this vital hormone product to the entire pharmaceutical industry. Under the agreement Research Corporation will license any financially responsible individual or firm. Full details may be obtained from the Division of Patent Management, Research Corporation, 405 Lexington Ave., New York 17.

Parke, Davis & Company has donated 5,000 doses of chloromycetin and 100 doses of typhoid-para-typhoid vaccine to El Salvador for the relief of victims of the recent earthquake. The Pan American Sanitary Bureau, regional office of WHO, sent 4,000 capsules of chloromycetin, 4,000 capsules of aureomycin, and 225 pounds of chlorinated lime. The supplies were flown to Central America by Pan American World Airways.

Chas. Pfizer & Co., Inc., in whose laboratories terramycin was developed, have donated \$11,000 worth of the antibiotic for use in the current cholera epidemic in India. Cholera is not among the infections on which terramycin has been definitively tested, but such tests are now under way in West Bengal, and medical reports are expected at an early date.

NRC News

National Research fellowships in the natural sciences, postdoctoral fellowships supported by the Rockefeller Foundation to promote fundamental research, have been awarded to 13 scientists. The new Fellows, with their institutions of study, are: Theodore Downs, American Museum of Natural History; Richard K. Benjamin, Harvard; Israel Zelitch, New York University Medical College; Conrad S. Yocum, Harvard; Layton L. McCoy, MIT; Barry M. Bloom, University of Wisconsin; Arthur S. Wightman, Institute for Theoretical Physics, Copenhagen; Malcolm P. Savendoff, Mount Wilson and Palomar Observatories; Victor L. Klee, Institute for Advanced Study; Louis Nirenberg, Swiss Federal Institute of Technology, Zurich; and Donald Robert Yennie, Institute for Advanced Study. One-year renewal appointments were granted to Harden McConnell, University of Chicago, and Maxwell A. Rosenlicht, Princeton.

Nine awards of Merck Postdoctoral Fellowships supported by Merck & Co., Inc., were made. New Fellows are: Philip S. Thayer, University of California; Lawrence Bogorad, The Rockefeller Institute of Medical Research; Roderick K. Clayton, Hopkins Marine Station; Ruth Hubbard, Carlsberg Laboratory, Copenhagen; Andre T. Jagendorf, University of California;

and Robert Roeske, Swiss Federal Institute of Technology. Renewal awards were made to Melvin Cohn, Institut Pasteur; James D. Watson, Institute for Cytophysiology, University of Copenhagen; and William A. Atchley, Rockefeller Institute for Medical Research.

The RCA Predoctoral Fellowships in Electronics, supported by the Radio Corporation of America, will give special graduate training in electronics to young men and women of marked ability. The 1951-52 awards were to: Casper W. Barnes, Jr., University of Florida; Bernard E. Keiser, Washington University; Seymour Stein, Harvard; Glen Wade, Stanford; and John N. Warfield, Purdue. Renewal awards were to Hiliard M. Wachowsky, Northwestern, and John G. Meeker, University of Michigan.

Meetings and Elections

At the April 11 meeting of the American Academy of Neurology at Virginia Beach, the following officers were elected for 1951-52: president, Pearce Bailey, Washington, D. C.; president-elect, Howard Fabing, of Cincinnati; vice president, Walter Klingman, Charlottesville, Va.; treasurer, Joe Brown, of Minneapolis; and secretary, Francis M. Forster, Washington, D. C. The next meeting will be held in the Brown Hotel, Louisville, Ky., on April 24-25, 1952. At the Virginia Beach meeting, a two-day course in neuropathology was instituted. This course will be given again at Louisville, as will a course in neuroroentgenography and electroencephalography. Requests for a place on the program should be sent to Alexander Ross, University of Indiana. Requests must be accompanied by the title and an abstract, and the deadline is November 1, 1951.

The Aero Medical Association, meeting in Denver, elected USAF Surgeon General Harry G. Armstrong 1951-52 president, and Dan C. Ogle vice president. Robert J. Benford, USAF (MC), was reelected to the Executive Committee. Designated as Fellows in the association were Benjamin A. Strickland, Loyd E. Griffin, and James B. Nuttall. In a concurrent session held by the Airline Medical Directors Association, Francis N. Kimball was elected president.

At the meeting of the American Society of Biological Chemists, Cleveland, the following officers were elected: president, Vincent duVigneaud; vice president, H. A. Mattill; secretary, Elmer H. Stotz; treasurer, P. P. Cohen. W. M. Stanley was elected councilor to serve with H. T. Clarke and C. F. Cori.

The American Society for Pharmacology and Experimental Therapeutics has elected the following officers: president, McKeen Cattell; president-elect, K. K. Chen; secretary, Carl C. Pfeiffer; and treasurer, Robert P. Walton. Walter F. Riker, Jr., Cornell University Medical College, was awarded the John J. Abel Prize in Pharmacology for his work on the pharmacology of neuromuscular function. This prize, consisting of \$1,000 and a bronze medal, has been donated by Eli

Lilly & Company for the purpose of stimulating fundamental research in pharmacology and experimental therapeutics by young investigators working in colleges, universities, hospitals, or any nonprofit institute.

The thirty-fifth annual meeting of the **Federation of American Societies for Experimental Biology** was held in Cleveland, Ohio, April 29-May 3. The federation is composed of The American Physiological Society, The American Society of Biological Chemists, the American Society for Pharmacology and Experimental Therapeutics, The American Society for Experimental Pathology, the American Institute of Nutrition, and The American Association of Immunologists. Geoffrey Edsall, president of the American Association of Immunologists, was chairman of the federation and presided at the joint session and at the meetings of the Executive Committee. The total attendance at the meeting was 4,787. Twelve hundred and ninety-eight papers, dealing with new research in the fields of the experimental medical sciences, were given at the 126 scientific sessions. At the joint session, three papers were presented covering subjects of wide general interest: Physiological Adaptation to Cold in Arctic and Tropic Animals (Laurence Irving, of the Arctic Health Research Center, USPHS); Hormonal-Enzymatic Mechanisms in Insect Growth and Metamorphosis (Carroll M. Williams, Biological Laboratories, Harvard); and Mechanisms of the Biological Effects of Penetrating Radiations (Cornelius A. Tobias, Donner Laboratory, University of California). These papers will be published in full in the June and September issues of *Federation Proceedings*. Sixty-two scientific and technical exhibits were on display, showing laboratory equipment, apparatus, books and journals, pharmaceutical, and other industrial researches and exhibits by federation members, foundations, and universities. The American Society for Pharmacology and Experimental Therapeutics, the American Society for Experimental Pathology, and the American Institute of Nutrition held dinner meetings, and various other groups arranged special functions and meetings during the convention. Symposia were presented by the American Physiological Society, the American Society of Biological Chemists, the American Institute of Nutrition, and the American Association of Immunologists.

The **Society for the Study of Evolution** will hold its annual meeting on the Berkeley campus of the University of California June 25-28. In addition to various papers, there will be two symposia, demonstration papers, and trips to Stanford University and the Division of Plant Biology, Carnegie Institution of Washington. G. Ledyard Stebbins, Jr., will lead the symposium on "Population Structure and Species Formation," and Reuben A. Sturton, the symposium on "Vertical and Horizontal Evolutionary Diversification." On June 26, the society will hold its first dinner meeting, at which the speaker will be Alden H. Miller, who will talk on "Current Research in Colombia by the University of California." Theodosius Dobzhansky,

of Columbia University, will give the first presidential address, "Creative Evolution," to which the public is invited. Those planning to attend should communicate with Robert C. Stebbins, Museum of Vertebrate Zoology, University of California, Berkeley 4.

The 1954 meeting of the **Ohio Academy of Science** will be held at Ohio University, Athens, and not at Ohio State, as published in *SCIENCE* May 4 (p. 541).

Miscellaneous

The Science Section, Bureau of Higher Education and Science, **Ministry of Education, Tokyo**, has prepared a list of foreign publications desired by Japanese universities. The list is in two forms: an alphabetical list of publications; and a list of publications desired by each university, junior college, and research institution. The lists are available from the Army's Reorientation Branch, New York Field Office, 139 Centre St., New York 13.

Mellon Institute has changed the title of its head, Edward R. Weidlein, from director to president. Dr. Weidlein has also been elected chairman of the board. John G. Bowman, president-honorarius of the University of Pittsburgh, was made vice president of the board, and George W. Wyckoff, secretary. Edward B. Clarke was appointed treasurer. Concurrently, these assistant directors have been named directors of research: E. Ward Tillotson, William A. Hamor, George D. Beal, Leonard H. Cretcher, and George H. Young.

The **Nature Conservancy** has published as the current issue of *The Living Wilderness* "Nature Sanctuaries in the United States and Canada," an inventory of all important areas having natural history values that are at least partially protected under public ownership. The inventory lists 691 nature sanctuaries, each characterized as to location, size, extent and kind of disturbances, type of vegetation, and principal mammals. Areas are arranged according to principal vegetation types of "biomes" (deciduous forest, prairie, etc.), and introductory discussions analyze the status of sanctuaries in each of these major types. Outline maps showing the sanctuaries for each type are included. Copies may be obtained for 50¢ each from S. Charles Kendeigh, 200 Vivarium Bldg., Wright & Healey Sts., Champaign, Ill.

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Carl F. Tessmer, formerly director, Atomic Bomb Commission, Hiroshima, has been appointed Commanding Officer, Army Medical Service Field Research Laboratory, Fort Knox, Ky.

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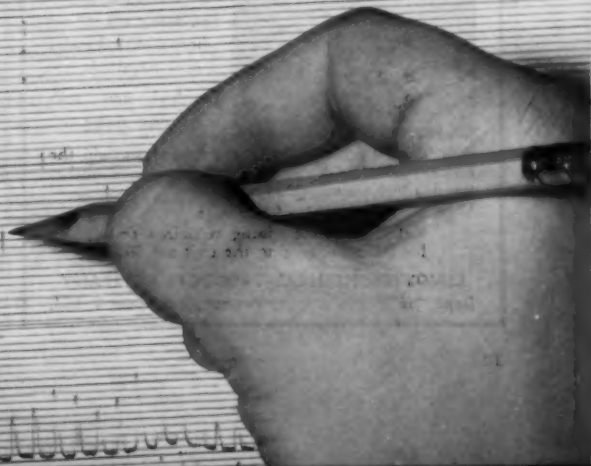
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Publications Received

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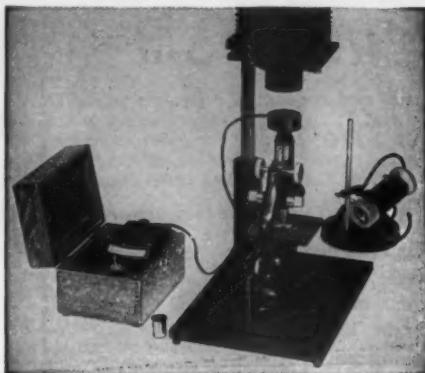
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- June 18-21. Special Libraries Association. Hotel Lowry, St. Paul.
- June 18-23. Pacific Division, AAAS. University of Southern California, Los Angeles.
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- June 19-21. American Meteorological Society (National). Los Angeles.
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- June 20-23. American Astronomical Society (Annual). Washington, D. C.
- June 21-27. Conference on Psychiatric Education. Cornell University, Ithaca, N. Y.
- June 22-23. American Academy of Dental Medicine (Annual). Hotel Dennis, Atlantic City.
- June 22-23. American Mathematical Society. Symposium on Applied Mathematics Fluid Dynamics. College Park and White Oak, Md.
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- June 25-26. Mathematical Association of America (joint with American Society for Engineering Education). Michigan State College, Lansing.
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- June 25-29. American Institute of Electrical Engineers. Royal York Hotel, Toronto.
- June 25-29. Institute for Annual Review of United Nations Affairs, New York University.
- June 26-July 5. World Congress of Illumination. Stockholm.
- June 27-July 3. International Union of Crystallography. Stockholm.
- June 28-30. American Society of Ichthyologists and Herpetologists. Chicago Natural History Museum, Chicago.
- June 28-30. Institute of Navigation (Annual). New Yorker Hotel, New York.
- June 28-30. National Science Teachers Association. Mills College, Oakland, Calif.
- June 28-30. International Meeting on Spectroscopy. Basel.
- June 29-30. Institute of Biology of Great Britain, Symposium on Freeze-Drying. London.
- July 2-4. International Conference of Naval Architects and Marine Engineers. Glasgow.
- July 2-6. South African Association for the Advancement of Science (Annual). Durban.
- July 3-6. Scientific and Clinical Convention of the Association for Physical and Mental Rehabilitation. Hotel Hollywood Roosevelt, Los Angeles.
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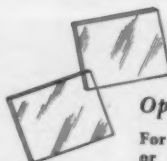
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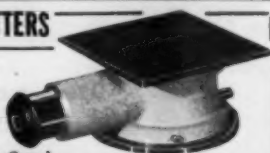
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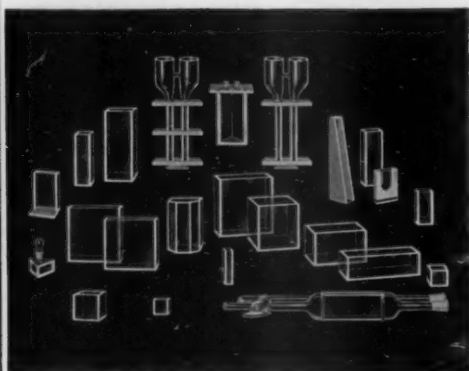
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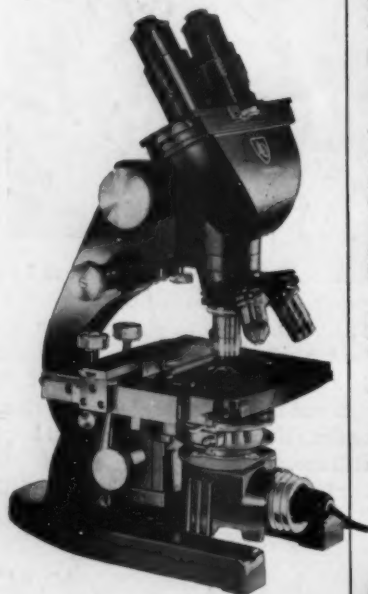
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